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INTERNATIONAL RACE TECH Motorsport Engineering

Volume 32 Issue 7
Published May 2025
The next issue will be published in early June 2025
ISSN 1356-2975

SUBSCRIPTIONS
Subscriptions from Kimberley Media Group Ltd
841 High Road, Finchley, London N12 8PT
Tel +44 (0)20 8446 2100

Overseas copies are sent via air mail
12 issue subscription UK: £71.40
Europe: £118, USA/Rest of World: £149
All major credit cards accepted. Cheques and money orders only in Pounds Sterling payable to Kimberley Media Group Ltd.

BACK ISSUES AVAILABLE:
8,9,10,11,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,52,53,54,55,56,57,58,59,60,61,62,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105,106,107,108,109,110,111,112,113,114,115,116,117,118,119,120,121,122,123,124,125,126,127,128,129,130,131,132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,148,149,150,151,152,153,154,155,156,157,158,159,160,161,162,163,164,165,166,167,168,169,170,171,172,173,174,175,176,177,178,179,180,181,182,183,184,185,186,187,188,189,190,191,192,193,194,195,196,197,198,199,200,201,202,203,204,205,206,207,208,209,210,211,212,213,214,215,216,217,218,219,220,221,222,223,224,225,226,227,228,229,230,231,232,233,240,241,242,243,244,245,246,247,248,249,250,251,252,253,254,255,256,257,258,259,260,261,262,263,264,265,266,267,268,269,270,271,272,273,274,275,276,277,278,279,280,281,282,283,284,285,286,287,288,289,290,291,292,293,294

Price including post & packing:
UK: £5.95, Europe: £6.50, Rest of World: £7.55
You can pay by cheque or credit card but please note the minimum on Switch & Delta is £14

Race Tech (ISSN: 1356-2975) is published monthly by Kimberley Media Group Ltd.

Cover image: DPPI/FIA/WEC

Design & Production: Paul Bullock

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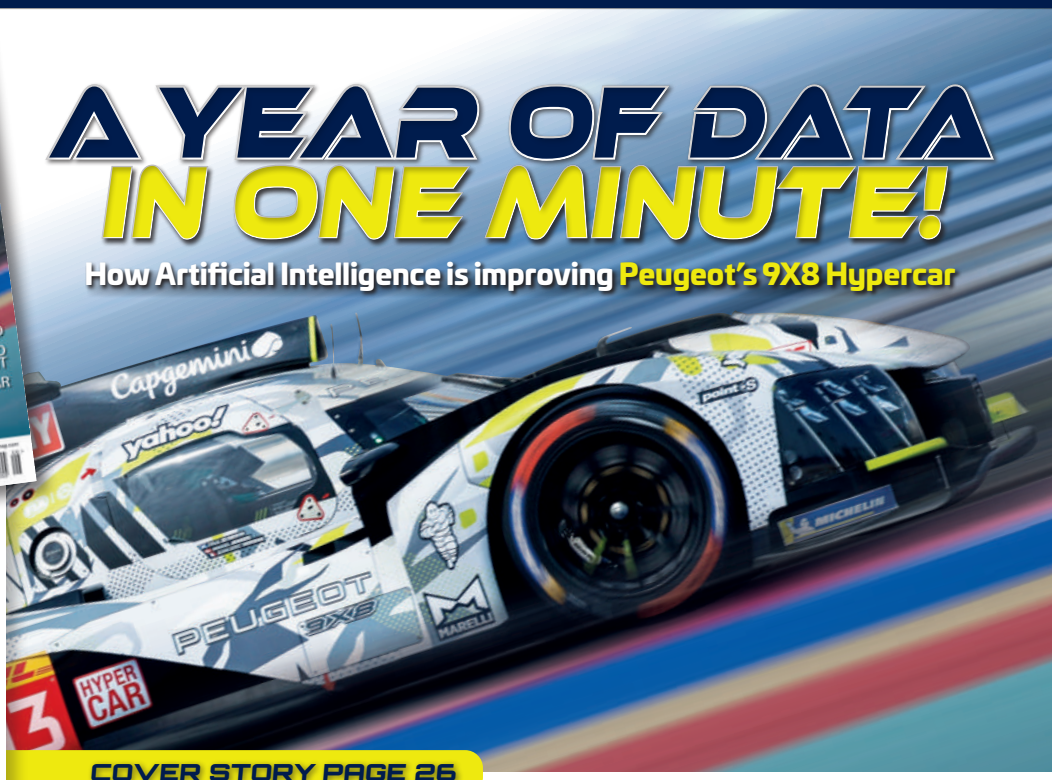

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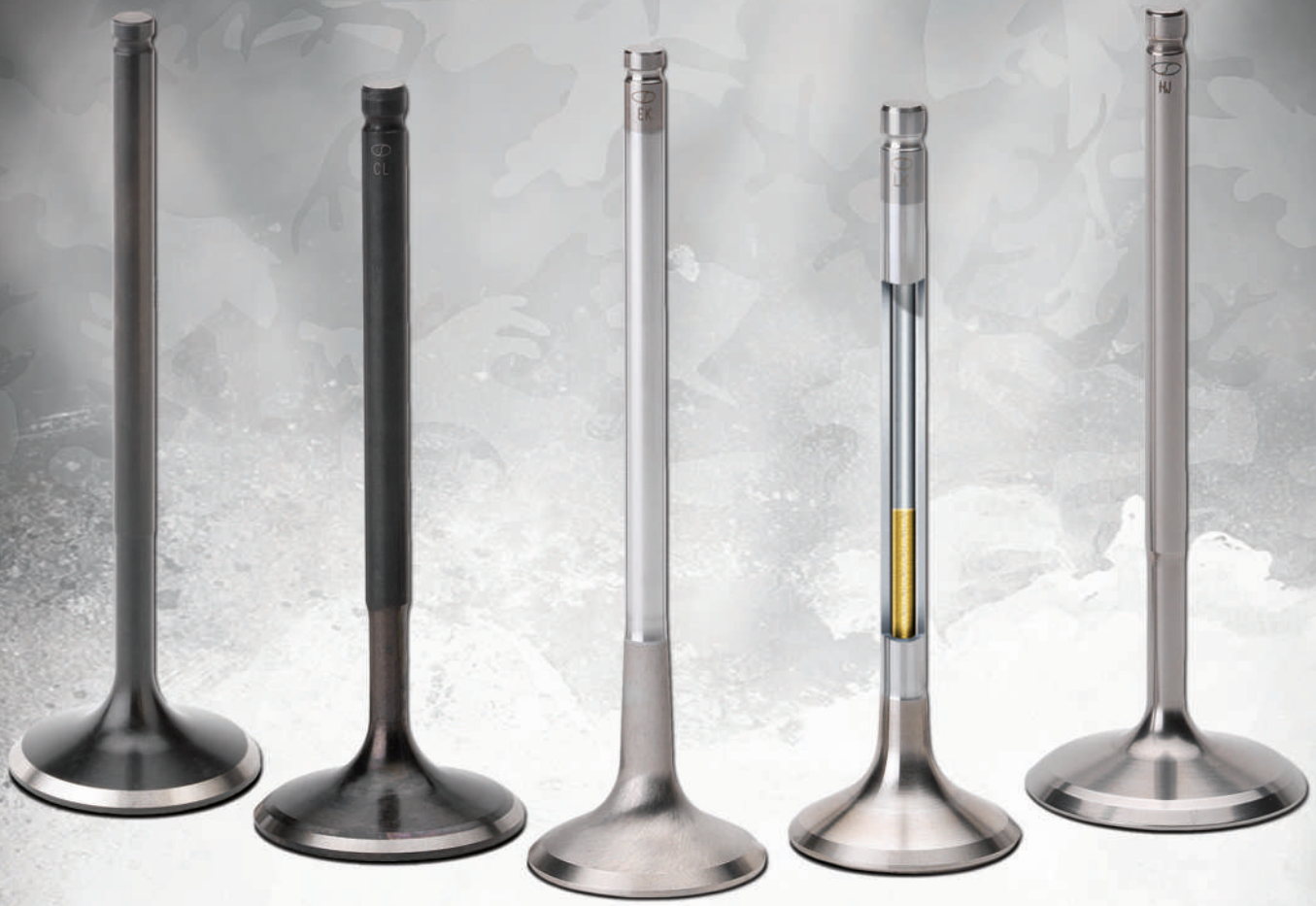

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A TALE OF TWO PRESIDENTS

FORMULA 1, Shakespeare and Donald Trump. Spot the odd one out, perhaps? Or a quick game of 'Where's Wally'? (I think we all know the answer to that one.)

All three sprang to my mind in the wake of the emergency meeting to discuss Formula 1's engine crisis.

The trick of an active mind, you might think, but it wasn't just my brain that was active. Although the summit was ostensibly triggered by FIA President Mohammed Ben Sulayem's provocative suggestion that we switch back to V10 engines, there was evidently some method to his madness!

Formula 1 has committed to developing the next generation of 1.6-litre turbocharged hybrid engines. It's a decision that was, at face value, a spectacular success: Audi, Ford and Cadillac lured in; Honda tempted back. All good. Except now everybody has to pay for it. And guess what? Donald Trump's throwing tariff grenades around indiscriminately.

OEMs facing financial Armageddon while simultaneously juggling the hefty bill for Formula 1's shiny new toys – what could possibly go wrong?

I appreciate none of you can remember there being any grenades in Shakespeare, but bear with: the famous bard was fond of his gods and the automotive giants are the deities of our motorsport world. Like the gods, they can sometimes seem capricious.

"As flies to wanton boys, are we to the gods. They kill us for their sport."

F1 CEO Stefano Domenicali speaking, or Gloucester in King Lear? Could have been either, for both are well aware of the sometimes-fickle nature of the giants who rule our world.

For more than half a century, the manufacturers have come out to play in motorsport's back garden when the sun is shining, lighting up our world with their good cheer, great technology and wonderful money. But when a storm threatens, especially a financial one, they will be gone in a heartbeat.

That's the nature of the almost parasitic relationship that motorsport often encourages, because we love the lure of the leviathans. But sometimes that deal with the devil backfires on us.

In the wake of the emergency meeting of the great and the good, Domenicali warned of the need for F1 to change its ways if it is to survive a financial meltdown of the type that saw Honda, Toyota and BMW all stampede to the exit door in quick succession in 2009.

But how can we weather that storm? Domenicali urges that we must have the courage to accept that the landscape has evolved.

The FIA doesn't want the ICE to be a performance differentiator anymore. A further dumbing down of our hybrids, already robbed of turbo compounding for 2026, seems inevitable but where will it all end?

The Trump-inspired meltdown is a shared problem that could result in a shared solution. Common gearboxes is one thing, but common engines quite another? Deeply uncomfortable territory. RT

Mark Skewis
EDITOR

PANICKED RETREAT TO V10S VETOED

Plot to rip up new regulations is foiled; F1 plans defence against impact of world turmoil. By **Mark Skewis**

RED BULL and Ferrari were both in favour of a proposal for a return to V10 engines when Formula 1 convened crisis talks in Bahrain last month. But opposition from Mercedes, Honda and Audi ensures that the new generation of V6 hybrid powertrains will go ahead – for now.

The meeting discussed a variety of possible solutions for the future of F1 engines, an FIA spokesperson said, including V6s and V8s as well as V10s. But it was accepted that the short-term focus should be on the success of the new rules, which are scheduled to run from 2026 until 2030. Whether hey make it that far is another matter...

"The FIA president was asking for feedback about what the next generation would look like. 2026 is absolutely fixed but thinking a bit further down the line for what's the right trajectory for F1," Red Bull team principal Christian Horner explained.

Asked about a potential return to V10s – a configuration not used in F1 since 2005 – Horner replied: "It's certainly not 2027; pretty much impossible for 2028, so it's all subjective. It's a fact-finding mission at the moment; it's down to the PU manufacturers to feed back to the FIA and it will progress from there."

FIA President Mohammed Ben Sulayem had courted controversy by championing a return to V10s, albeit run on sustainable fuel. After the meeting, the governing body said in a statement that the aim of the gathering was "to seek cost-effective solutions to safeguard the long-term sustainability of the sport and the business of F1".

It added that the FIA had firmly committed to the 2026 regulations, which had "attracted new power-unit manufacturers to the sport, underlining that for the 2026 cycle the correct technical path has been chosen".

The FIA statement said it had been agreed at the meeting that "electrification will always be a part of any future considerations" and that "the use of sustainable fuel will be an imperative".

The latter point – regarded by some as a free pass to explore alternatives to the V6 hybrids – does potentially leave the door open for a later return to a V8 engine with some form of simplified and less powerful KERS system.

The 2026 regulations retain 1.6-litre V6 turbo hybrid engines but simplify their hybrid systems by deleting the turbo compound element (MGU-H), with exhaust heat recovery more prevalent in heavy-duty trucks than in road cars. The proportion of total power provided by the electrical part of the engine is increasing from 20% to about 50% – although there is a controversial proposal to reduce that – while the use of fully sustainable fuels is a central pillar of the new rules.

Despite the immediate reprieve for the 2026 regulations, the idea of changing the engine formula before 2031 remains open to discussion. There is also a focus on reducing cost and complexity in the engine rules.

"Totally wrong"

Given that the manufacturers have already spent hundreds of millions of pounds on the next generation of engines, some had expressed incredulity that the prospect of scrapping the 2026 regulations should even be up for discussion. Nevertheless, F1 CEO Stefano Domenicali confirmed that, "Someone tried to push for an extension of the current regulations".

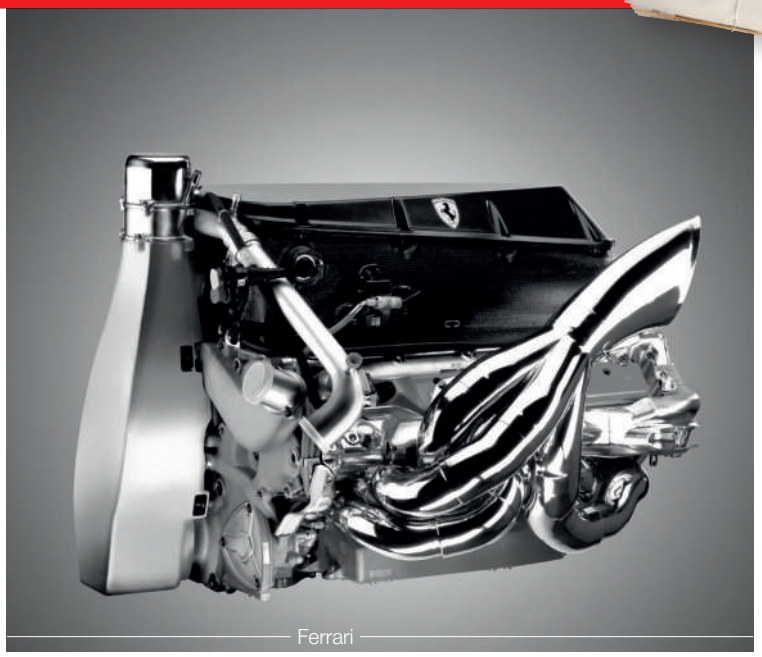
"That would have been totally wrong," he added. "We must respect those who've invested heavily in this complex and costly project – changing the rules now would send the wrong message. Questioning previous decisions on power units would be a huge mistake."

Although those present at the meeting were split over the issue of a return to V10s, one thing they all agreed upon was the need to insulate Formula 1 against the impact of a world economic crisis.

Domenicali agreed with the FIA president that cutting costs is key to protect the series against economic fluctuations and avoid a repeat of 2009's mass exodus, when Toyota, BMW and Honda all walked out of the series in quick succession.

"It would be naive not to consider that possibility, especially given today's

FIA


Ferrari

ABOVE Ferrari was one of the teams in favour of a return to V10s, the engine configuration with which it enjoyed so much success during its Schumacher era

economic climate," the Italian said. "Renault, after many years, has left F1 [as an engine supplier]. Let me be clear: major manufacturers are essential, but we're also mature enough to know that, if a severe crisis hits the industry, big automotive groups might have to make tough decisions.

"That's why we must simplify and significantly reduce costs, while maintaining a technical link to road-relevant technologies – like sustainable fuels, which can complement EV offerings. If a crisis forces some to pause their F1 programmes, we'll be in a position to respond independently and find alternatives."

LEFT Some pushed, unsuccessfully, for an extension of the current rules

Ploughing ahead with the new V6 hybrids does, of course, raise the spectre of one PU manufacturer stealing a huge march in its rivals. Mercedes blew away its opposition at the start of the last regulatory powertrain cycle in 2014 and the word is that history could repeat itself in 2026. The rumours certainly seem to have focused rivals' minds, easing the path towards some sort of catch-up mechanism being put in place this time around.

"We're on the brink of a major regulatory shift, and I personally believe it's crucial that the system allows for a faster recovery if a manufacturer falls behind significantly," said Domenicali. "That's an issue we must address quickly – it could happen to anyone."

"We all need to think strategically," he cautioned. "Having one dominant team for too long is bad for everyone. Our sport is growing incredibly and has become a global benchmark. We should be proud of that – but also cautious."

Crisis averted?

Nowhere would a bigger sigh of relief have been breathed than in the Audi boardroom. The German giant had, after all, been lured into F1 on the promise of a brave new sustainable era, rather than a knee-jerk, slapdash descent back into a V10 configuration that none of the major OEMs even produce anymore.

A spokesperson for Audi said: "Our aim is to help shape a sustainable and future-oriented form of motorsport that leverages cutting-edge technologies, benefiting not only F1 but also Audi's broader technological development which we see reflected in the 2026 power unit regulations.

"Audi remains fully committed to entering Formula 1 from 2026 onwards, with power unit technology built around three key pillars: highly efficient engines, advanced hybrid electrification, and the use of sustainable fuels."

Mercedes, Ferrari and Honda will all stay in the sport from 2026, with Red Bull Powertrains, in partnership with Ford, supplying power units for Red Bull and Racing Bulls.

Honda had planned to leave F1 after this year but will stay in the sport, albeit as the sole supplier to Aston Martin. Audi will join F1 for the first time as it takes over Sauber.

The new Cadillac F1 team will also join the grid in 2026, and will run under Ferrari power, but plans to use its own power unit by the end of the decade. General Motors was also present at the emergency meeting.

Audi AG

RIGHT Audi reaffirmed its commitment to enter F1 after the meeting

Reid resignation piles pressure on president

THE pressure on FIA president Mohammed Ben Sulayem ratcheted up a notch last month with the resignation of Robert Reid, deputy president for sport at the FIA, over what the Scot described as "a fundamental breakdown in governance standards within motorsport's global governing body".

Reid said in a statement that he was experiencing "growing alarm over critical decisions being made without due process or proper consultation".

"When I took on this role, it was to serve the FIA's members, not to serve power," Reid said. "Over time, I have witnessed a steady erosion of the principles we promised to uphold. Decisions are being made behind closed doors, bypassing the very structures and people the FIA exists to present."

"Came at a cost"

A week on from his resignation bombshell, the former FIA number two reflected on the turbulent period, writing on *Substack* that he had been overwhelmed and humbled by the support he had received.

"I never expected that stepping away from something I care so deeply about would resonate so widely," he said. "It reinforces my belief that integrity and values still matter, not just in words, but in how we lead.

"It is interesting, but not wholly surprising, that many of those messages of support came with the caveat of not being willing to say anything publicly for fear of retaliation, which highlights some of the issues we face... From other quarters the silence has been deafening."

Reid – whose replacement is likely to be M-Sport founder Malcolm Wilson – stressed: "My decision to resign was not about personalities or politics. It was about principles. I took on this role with a clear mandate: to help lead a transparent, accountable, and member-led federation. While some early progress was made, I ultimately found myself unable to continue within a system that no longer reflected the standards I believe the FIA must uphold."

Reid said "the final breach of trust and due process" that led to his resignation was a recent decision to take in-house the promotion of the World Rallycross Championship without approval by the FIA senate or world council. He pointed out that this action could carry legal risk under European Union competition law.

He was also at pains to address recent speculation regarding the Non-Disclosure Agreement amendment which resulted in his exclusion from a World Motor Sport Council meeting and, 10 days later, the disabling of his FIA email account. He stressed that he did not refuse to sign the NDA, but instead asked for a short extension in which to seek legal advice on a complex issue.

Reid said that he fully supports the need for confidentiality and had been deeply frustrated at the number of leaks "that undermine trust and effective governance".

He added: "One journalist said to me that perhaps the FIA should be more concerned with *why* people are leaking than *who* is doing it and I think that's worth reflecting on.

"I spoke up when I felt fundamental principles were being eroded. I did so respectfully, constructively, and always with the aim of safeguarding the integrity of our sport. But doing so came at a cost. It became clear that raising legitimate concerns was not always welcomed and I experienced firsthand how challenging the status quo can lead to exclusion rather than dialogue. I don't regret speaking up. But I do believe I was treated unfairly for doing so.

"Leadership matters. Governance matters. And trust, once lost, is hard to rebuild. If motorsport is to remain credible and thrive into the future, it must be governed not by control, but by collaboration. Not by silence, but by accountability."

Reid's resignation came after MotorsportUK chairman David Richards wrote an open letter to the organisation's members accusing the FIA of a "shift of moral compass".

Ben Sulayem's first term ends this year and he is up for re-election in December. So far, he is unopposed but there is said to be at least one potential opponent readying a campaign, with the names of Richards and Reid – both former rally world championship-winning co-divers – being bandied around. However, the FIA recently reduced the age limit for candidates from 75 to 70. Richards is 72 years-old, making him ineligible to stand.

So, what of Reid? "A lot of people have asked what comes next," he admitted. "The truth is, this was never about a 'next move'. It was about saying: 'This isn't good enough, and I can't be part of it anymore'." RT

Getty Images/Red Bull Content Pool

ABOVE Reid (right) was a key member of Ben Sulayem's team

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LEFT The AI-powered safety camera can identify spectators in unsafe positions in real time

AI Safety Camera makes successful rally debut

THE opening round of the 2025 FIA European Rally Championship marked the debut of a major safety innovation, as the FIA's new Artificial Intelligence Safety Camera (AISC) was deployed for the first time at last month's Rally Sierra Morena.

Rallying is one of the most challenging environments in motorsport for managing spectator safety, with stages often extending across remote terrain for tens of kilometres. The AISC has been developed to meet these challenges, offering rally officials real-time, stage-level insight into spectator locations.

Mounted on competing cars, the system uses AI-powered human detection to identify spectators along the stage route, including those moving into unsafe areas during the rally. As competing cars pass through the stage, the system captures spectator locations and processes this data instantly, transmitting alerts to event officials so that pre-emptive safety measures can be taken before the next competitor arrives.

At the heart of the AISC is a self-sustaining, GPU-enabled camera connected to a processing unit that performs on-board image analysis and detects unsafe spectator positions. The unit filters the data and transmits it to a web-based user interface, where snapshots of unsafe scenes are received. This enables the Chief Safety Officer to pinpoint the location of spectators in hazardous areas and resolve issues via an advanced issue management system.

The AISC allows safety officials to identify and address potential risks before they escalate, offering a level of real-time oversight that would be impossible through manual monitoring alone.

The device has the biggest potential to improve spectator safety on regional and national events where there is often a lack of video coverage from the competition cars.

"The introduction of the AI Safety Camera allows us to take a huge leap forward in how we monitor and manage risk during events," said FIA Safety Director, Nuno Costa. "This technology isn't about restricting fans, it's about protecting them. It allows organisers and officials to respond rapidly and ultimately allows them to prevent accidents before they happen."

IndyCar fans to get Driver's Eye view

RACING Force Group has signed an agreement with FOX Sports, the TV rights holder of the NTT IndyCar Series, for the use of the Driver's Eye technology in selected events of the 2025 season, including the 109th running of the Indianapolis 500.

Fans of Formula 1, Formula E, and NASCAR have already seen the technology from RFG in use with the tiny HD cameras placed inside drivers' helmets.

The Driver's Eye, developed by Zeronoise, the electronics division of Racing Force, is the world's smallest micro-camera for live broadcasting. The FIA-homologated system is installed inside the helmet to give TV viewers the totally immersive experience of the driver's exact point of view during the race. The micro-camera has a size of only 0.35 × 0.35 inches and a weight of 0.003 pounds.

The Acura Grand Prix of Long Beach was the launching pad for the Driver's Eye with IndyCar. However, much wider use of the technology is expected this month, with the camera playing a big part in FOX Sport's first airing of the Indianapolis 500.

The Racing Force Group is present on three continents, with main headquarters in Ronco Scrivia (Italy), Sakhir (Kingdom of Bahrain) and Mooresville (United States). Its brands include OMP, Bell Racing, Zeronoise, Racing Spirit, and HPS.

BELOW Driver's Eye was trialled at Long Beach

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Yamaha and Lola extend Formula E deal

ABOVE Yamaha views Formula E as a crucial part of its journey into electrification

THE alliance between Yamaha Motor Co Ltd and Lola Cars to compete in Formula E is to extend into the championship's Gen4 era.

Formula E will introduce its fourth-generation cars from Season 13 (2026-2027). The shift will involve the increase in maximum power to 600 kW and maximum regenerative braking being raised to 700 kW.

Yamaha has set a companywide environmental goal to achieve carbon neutrality in Scope 3 emissions by 2050. Additionally, its Technology Vision includes strengthening core competencies such as energy management – an ambition it believes is well served through its collaboration with Lola to develop an electric powertrain in Formula E.

"Having already committed to Gen4 ourselves, I'm so pleased that Yamaha will be continuing this journey in electric racing with us," said Till Bechtolsheimer, Chairman of Lola Cars. "With their vast experience and commitment to advancing sustainable mobility, they are the perfect partner for Lola Cars."

Last month Yamaha also heralded what is potentially a new era for MotoGP by testing a V4 motorcycle engine at Valencia. The radical move comes ahead of the upcoming 2027 MotoGP regulations and Michelin tyres. The V4 engine is expected to be more efficient in managing tyre performance than the current inline four and could potentially offer a narrower engine layout for an aerodynamic advantage. RT

McLaren returns to Le Mans

BELOW The Le Mans-winning McLaren F1 GTR, flanked here by F1 GTR Longtail and F1 LM, already has pride of place at McLaren's facility

Newspress

McLAREN has become the latest manufacturer to commit to the FIA World Endurance Championship's burgeoning Hypercar class, with the iconic British brand confirming it will enter the fray in 2027.

McLaren has been absent from the discipline's top-tier since 1998, and this year marks the 30th anniversary of the company's milestone win at the 24 Hours of Le Mans with the F1 GTR crewed by JJ Lehto, Yannick Dalmas and Masanori Sekiya, as the legendary marque secured four of the top five positions in the overall classification at La Sarthe in 1995.

The news was confirmed initially with a social media post. "We're back!" said McLaren Racing CEO Zak Brown. He added, in an interview with local broadcast network, beIN Sports: "A lot comes into play when you make a decision like this – how we're doing in Formula 1, our IndyCar team, our Automotive business – and things have really never been better, so the timing is definitely good.

"With the rules that the Automobile Club de l'Ouest, the World Endurance Championship and IMSA have come up with, everyone has voted with their cars and look at the field – it's amazing with all the manufacturers, the drivers, the competition. This is a very exciting time in endurance racing."

McLaren will join Hypercar with an LMDh prototype. It is believed that it has partnered with Italian constructor Dallara, which has also co-developed the Cadillac V-Series.R and BMW M Hybrid V8.

The engine is expected to be based on the architecture of the 120-degree twin-turbo V6 already in use in both road and race versions of the Artura introduced in 2022.

The marque returned to Le Mans in 2024 on the introduction of the LMGT3 class in the WEC, partnering with United Autosports to run the 720S GT3 Evo.

McLaren joins Hyundai's luxury brand Genesis and automotive heavyweight Ford in confirming its addition to the FIA WEC Hypercar grid in the coming years. RT

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- **PDM-5** can be configured to become a dedicated Headlight or Spot Lamp controller.
- **PDM-4C** incorporates CAN Bus connectivity for transmitting diagnostic data including output status, volts, amps, configuration settings, etc. Outputs can also be controlled through CAN Bus.

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Future of LMP2 takes shape

BELOW The LMP2 ruleset gets a reset for 2028

DPPI/FIA

THE future shape of endurance racing's super-successful LMP2 category becomes clear next month, when the winning tenders for chassis and engine supply contracts are revealed.

The last major rule change in 2017 funnelled the number of possible chassis constructors from an open net to just four – ORECA, Dallara, Multimatic and Ligier – and introduced a spec V8 engine, in a bid to limit costs. However, the popularity of ORECA's 07 chassis ensured that LMP2 became a de facto single spec category.

The FIA and ACO's next-generation tender process will effectively recognize that fact. From the 2028 season onwards, the number of eligible suppliers for the European Le Mans Series, Asian Le Mans Series, IMSA SportsCar Championship (subject to a dedicated contract) and FIA WEC (via Le Mans) is being reduced to a "maximum of two".

Chosen suppliers are expected to produce chassis from 2028 through to the end of 2032 and must be able to guarantee parts availability for a minimum period of 10 years.

The overall estimation by the FIA and ACO is that 40 units will be needed to cater for the cars competing in the eligible championships, with a mileage of approximately 40,000 km per car, per year.

Gibson Technology's GK428 engine, a naturally aspirated 4.2-litre V8, is the heartbeat of the existing LMP2 formula, having clocked up well in excess of five million kilometres since its introduction in 2016.

Gibson was initially awarded an extension to its engine supply contract, only for the proposed regulation set to be scrapped ahead of last year's Le Mans 24 Hours.

The new powertrain tender requires the next engine to be 'low displacement' and turbocharged, preferably with direct injection. A proposed minimum lifespan of a single engine has been set at 14,000 kilometres (8,700 miles). RT

Gibson rings the changes

GIBSON TECHNOLOGY, currently the sole supplier of LMP2 powerplants, has made a number of personnel changes.

Dr Gareth Pugh has joined as Head of Engineering and Projects. He brings 25 years of experience leading innovative engineering projects across ICE, hybrid and EV automotive development and racing.

"His expertise will significantly strengthen our ability to develop and deliver cutting-edge powertrain solutions, and advanced engineering technologies," explained Gibson Technology MD Mark Brittan.

Elsewhere, Bob Baker has taken on an expanded role as Head of Customer Relations, while Ian Lovett's role has evolved to Technology and Strategy Director. In this capacity, Lovett will guide Gibson's future technology initiatives, R&D and strategic business growth.

ABOVE The LMP2 field has racked up in excess of five million kilometres with Gibson's GK428 engine

The company has also made a number of organisational changes, with John Manchester transitioning to the role of Advisory Director, providing valuable counsel based on his extensive experience.

Jim Hibbert has moved into the role of Operational Director. Yutaka Hiwatari has been appointed Chief Technical Engineer.

"These changes are driven by our commitment to continuously improve and innovate, ensuring we not only widen our customer base but also remain focused on the trusted partners we currently work with," said Brittan. RT

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NASCAR rebels drag F1 into antitrust lawsuit

THE battle that could reshape the future of NASCAR took a further twist last month.

The two teams bringing an antitrust lawsuit against NASCAR, Michael Jordan's 23XI Racing and Front Row Motorsports, want a Colorado court to force F1 owner Liberty Media to comply with a subpoena to produce financial information.

The legal battle revolves around the teams' refusal to sign NASCAR's charter agreement and what they refer to as an unlawful monopoly managed by the France family. Although F1 has no charters, there is a Concorde Agreement that originated in the 1980s and has been frequently updated since.

The latest request is in the context of an overall legal strategy in which the teams want to juxtapose the business model of NASCAR with that of other high-profile sports.

Liberty Media initially resisted, arguing that the subpoena is "overbroad" and seeks confidential business information. The teams have subsequently trimmed down their request and filed a motion in federal court to compel Liberty Media to comply.

Formula 1 isn't the only other sport being dragged into the case. The teams are also seeking financial information from the American football, basketball and hockey leagues: the NFL, NBA, and NHL.

"That information will enable Plaintiffs to perform a yardstick comparison between the other major professional sports leagues (where competition is not precluded) and NASCAR (where exclusionary conduct has been used to unlawfully maintain a monopoly)," the teams wrote in their brief to compel the other sports to comply.

ABOVE Formula 1's division of money is wanted as a yardstick with which to compare NASCAR

In its opposition, the NFL wrote: "The Subpoena is based on the flimsiest of premises: that because Plaintiffs are suing NASCAR, they can obtain – by way of federal process – financials, financial projections, research, studies, analyses, and other highly confidential, proprietary, and commercially sensitive information belonging to almost every other major sports league in the United States."

Counterclaim

NASCAR, meanwhile, has filed a motion to amend its counterclaim against 23XI Racing and Front Row Motorsports based on information found during discovery.

In its motion, NASCAR says that after the deadline for filing its counterclaim, the teams "produced more than 200,000 pages of emails, texts, and memoranda. Those documents indisputably confirm what NASCAR alleged in its counterclaim: 23XI, Front Row, and Curtis Polk knowingly entered into illegal agreements with other teams on issues such as fixing the compensation that they received from NASCAR and allocating how that compensation would be divided among the co-conspirator teams."

NASCAR wants to amend its counterclaim to include the documents.

Polk, a co-owner of 23XI Racing, was included in the counterclaim. In its new motion, NASCAR suggested the documents confirm that he "was the ringleader of the concerted effort to set compensation received by the teams, boycott NASCAR events, interfere with NASCAR's negotiations with media partners, and reach unlawful agreements." RT

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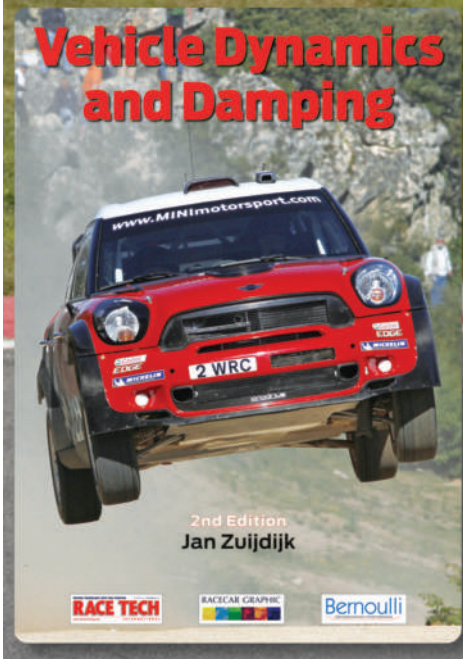

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RIGHT The battery-electric McMurtry Spéirling PURE Validation Prototype was inverted

Yes, you *can* drive it upside down!

IT often used to be said that Formula 1 cars produced so much downforce they could be driven upside down. Now, McMurtry Automotive has proved the theory with its record-breaking Spéirling hyper track car.

Thomas Yates, Co-founder & Managing Director of McMurtry Automotive, used the British hypercar's proprietary fan system to 'suck' it to the 'floor' of a specially-built rotating rig. The technology demonstration took place at McMurtry's headquarters in Gloucestershire, England and was attended by employees and independent adjudicators.

"That was just a fantastic day in the office!" commented Yates. "Strapping in and driving inverted was a completely surreal experience. The 2000 kg of downforce that the fan system can generate is truly astonishing to experience and it's great to show the reason why our Spéirling continues to take records around the world.

"This demonstration was an exciting proof of concept using a small purpose-built rig, but is perhaps just the beginning of what's possible. With a longer inverted track or a suitable tunnel, we may be able to drive even further!"

Equipped with McMurtry's patented Downforce-on-Demand system, the Spéirling's downforce is available at any speed, even at a standstill. Other hypercars and racecars can only produce downforce at high speeds using aerodynamic surfaces.

During the record attempt, Yates drove the Spéirling up a ramp and onto a purpose-built platform. The floor of the platform then rotated, fully inverting the hypercar. The Downforce-on-Demand system created a sufficient vacuum underneath the hypercar's floor to hold it upside down, exceeding the force of gravity. Once fully inverted, Yates drove forward, entirely unsupported.

Already holder of the Goodwood Festival of Speed and Laguna Seca Corkscrew hillclimb records, the single-seat, electric hypercar has also smashed the Top Gear Test Track record by 3.1 seconds. The previous record holder was a V10 Renault R24 Formula 1 racecar from 2004. RT

911 GT3 R successor trialled at Spa

BELOW Herberth Motorsport fielded an updated 911 GT3 R, finishing second overall

WHILE the highly successful Porsche 911 GT3 R continues to chase victories around the globe, its 'evo' successor is already waiting in the wings. The development programme for the new customer racing model, based on the current GT3 race car, ramped up with an outing for Herberth Motorsport in the Creventic 24h Series12H at Spa.

"The Spa-Francorchamps circuit poses a formidable challenge for both drivers and machines," said Sebastian Golz, Project Manager Porsche 911 GT3 R. "As a long-time Porsche customer team, Herberth Motorsport provided valuable feedback on vehicle handling, serviceability, ergonomics, and operational functions. We were also eager to hear the drivers' impressions."

The evolution of the Porsche 911 GT3 R is set for public reveal in the summer. For the 2026 racing season, Porsche engineers have placed a strong emphasis on enhancing driveability. Modifications to aerodynamic components aim to reduce pitch sensitivity – improving front-end behaviour under braking and acceleration.

Important software updates have also been implemented, and the steering system has been refined by the engineering team in Weissach. RT

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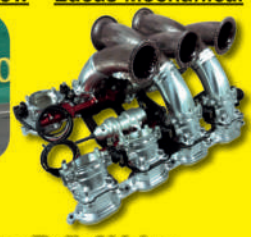

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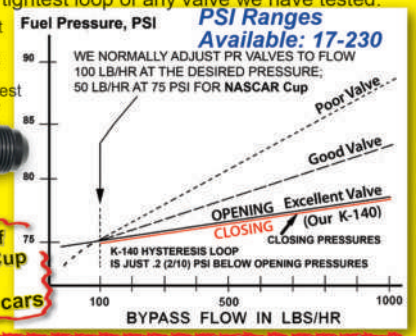

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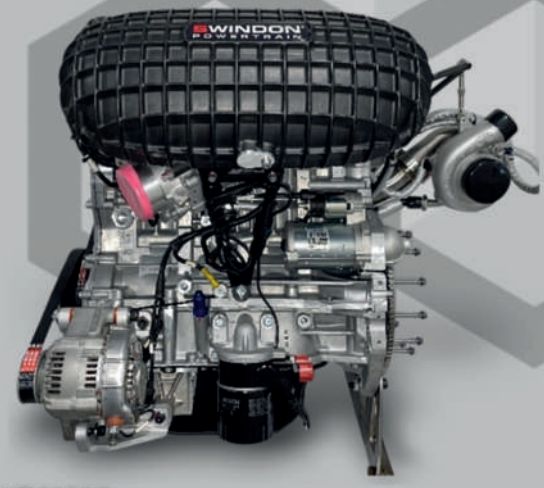

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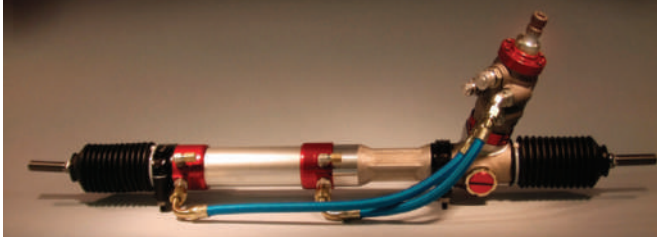

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Stand together, urges new NASCAR commissioner

IN HIS first interview since being appointed NASCAR's new commissioner, Steve Phelps reiterated the importance of everybody in the sport pulling together.

"The most important thing for us is the continued rush toward collaboration with our industry," Phelps said on Hauler Talk, NASCAR's official podcast, "and whether you're talking about racetracks that we don't own or you're talking about teams or you're talking about drivers, it is important that we come together as one. And we are at a competitive disadvantage because we don't own ourselves as an entity. We are not a league.

"But in my opinion, the more we act like a league, the better it'll be for all stakeholders. Not just NASCAR the company, but NASCAR the sport because we are stronger together than we are apart. So, to me, that is the No. 1 thing in my job that is the most critical."

LEFT Phelps says NASCAR's biggest threat is the industry not working together

Phelps, who will oversee all aspects of NASCAR and IMSA, had served as NASCAR president since 2018. Steve O'Donnell has been named his successor as president.

Quizzed on why the sport needed a commissioner, Phelps said: "It's a time that our sport has experienced growth. There was a time when we had some significant declines. But it's a time since 2019 that looks different and feels different.

"If you're in this sport, it feels good right now," he continued. "The competition is amazing. The ratings are strong. We've got new media partners. Charter values are soaring. We've got wind at our back. OK, now what? That's really what it was. Whether it's international growth or just the opportunities afforded to us with my elevation."

After overseeing a new media rights deal, the rollout of the Next Gen car and a revamp of the schedule in the past five years, Phelps said global growth would be a heavy focus to maintain the momentum as commissioner.

"International expansion is fertile ground for us," he said. "What that looks like, we're studying now. We have series in Brazil, Mexico, Canada and Europe. Is that the right model to continue expansion that way, or should we think more broadly of what it's going to look like that looks different than that? We're exploring all of those things." RT

Dooley named director of IndyCar's feeder series

VETERAN racing industry executive Kirk Dooley has been named as director of INDY NXT by Firestone. He will oversee all operations and competition for IndyCar's developmental series.

Dooley, 51, assumes his new role in a return to IndyCar after serving as the Chief of Staff in 2015-16, when he helped coordinate key series financial initiatives and evolve technical regulations. In 2016, he was named director of event operations at Indianapolis Motor Speedway, where he was responsible for the management and execution of all IMS events including the Indianapolis 500.

In 2020, Dooley became chief operating officer of the renowned Skip Barber Racing School.

A 24-year Marine Corps Officer, who spent the majority of his time in the intelligence and special operations community, Dooley most recently served as the owner of Indianapolis-based Torque Lab, LLC, which provides a wide range of engine management software and racing services to affiliated performance shops, race teams and personnel. RT

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FIA reveals safety blueprint for entry-level touring cars

THE FIA has introduced a new set of Technical Guidelines for entry-level touring car racing, aimed at supporting grassroots motorsport in developing countries. The guidelines provide a flexible framework for FIA Member Clubs looking to establish affordable club-level racing while meeting essential safety standards.

The guidelines do not impose restrictions on power or vehicle specifications, focusing solely on safety and covering areas such as the safety cage, windows, bodywork, fuel systems, driver safety equipment, cockpit and driver access, brakes, wheels and tyres, suspension, steering, electrical system, fire protection and towing, while at the same time allowing FIA Member Clubs flexibility in defining performance aspects to suit local conditions.

"The FIA is dedicated to doubling motorsport participation and enhancing global accessibility, and this vision begins with a solid foundation at the grassroots level, where safety is essential," said Mohammed Ben Sulayem, FIA President.

"By offering these blueprints to our Member Clubs, we can directly empower them to grow and strengthen their domestic entry-level touring car competitions."

Accessible and adaptable

"Our role as the FIA, amongst other things, is to share expertise and know-how with our Member Clubs and therefore raise the standards at grassroots and club-level racing," added FIA Touring Car Commission Chairman, Alan Gow.

"At the same time, we recognise the fact that grassroots touring car racing must be accessible and adaptable to local conditions. By focusing on safety, these guidelines give the FIA Member Clubs the freedom to shape their championships while maintaining key safety standards. Even countries with established motorsport, like the UK, should benefit. After the TC Lite ruleset release last year, this is another step towards making touring car racing more popular and more accessible than ever before."

The definition of the guidelines has met with positive reception among FIA Member Clubs.

"Establishing clear safety standards for entry-level touring car racing is essential," admitted Andrew Fraser, President of Motorsport Australia.

"Safety is the number one priority for Motorsport Australia and clearly defining these standards is key to protecting the motorsport community," added Sunil Vohra, CEO of the club.

Australia is a country with a broad and vibrant touring car racing scene, from grassroots competitions such as the Hyundai Excel one-make racing, all the way up to the Supercars Championship. Yet, the strength of the guidelines is that they will be universally available to clubs regardless of the level of motor sport in their respective countries.

The FIA brings together 245 Member Organisations, across five continents.

"In Mozambique, where motorsport is still developing, we find ourselves needing to make certain concessions to make it accessible, affordable, and sustainable. Safety standards are fundamental for us." said Miguel Tiago, Director at Automobile and Touring Club of Mozambique, a club known for governing grassroots touring car racing at Autódromo Internacional de Maputo, the country's only active racing circuit.

"A standardised document is essential for achieving a delicate balance between affordability and accessibility. When individuals see that established safety measures are in place, they are more likely to engage in racing, and this is our main objective," he summarised.

Tiago also praised the fact that the guidelines can be adapted to a wide variety of vehicles: "By customising our regulations to fit our domestic market, we can ensure that the safety standards are relevant to the types of cars available locally. This adaptability encourages participation from local drivers who may not have access to high-end racing vehicles, yet can compete in cars that are common in Mozambique but equipped with current safety measures."

The hope is that by ensuring club-level touring car racing meets fundamental safety criteria, it will provide competitors with a clear pathway towards higher classes such as TC Lite, TCR or GT racing.

BELOW The guidelines define clear safety standards for entry-level touring cars

Domenicali renews F1 deal

Red Bull Content Pool

ABOVE Domenicali is respected by the drivers

FORMULA 1 President and CEO Stefano Domenicali will lead the business through to 2029 after signing a five-year renewal of his agreement with Liberty Media.

Formula 1 is currently enjoying a period of strong progress, with momentum in fan growth and engagement alongside commercial success across all business areas including sponsorship, media rights and race promotion.

Derek Chang, President and CEO of Liberty Media, said: "Stefano has been an excellent steward of the business, building on its successful foundation and accelerating Formula 1's rate of growth both commercially and in fan engagement. His energy and enthusiasm for the sport translate into highly effective strategy and results."

Domenicali said: "The passion, the energy and the adrenaline are the fuel that powers me every day to give my absolute best to Formula 1. I am grateful to the Liberty Media team for their trust. Together, with all the relevant F1 stakeholders, we will continue to serve the best interest of our fans, as they are the heartbeat of everything we do."

Former team principal at Ferrari, Domenicali joined Audi AG as Vice President of New Business Initiatives in 2014 and was appointed Chairman and Chief Executive Officer of Automobili Lamborghini in 2016. During his time at Lamborghini, he successfully grew the brand in major global markets, recording strong financial results.

His inside knowledge of the sport and the respect in which he is held has become increasingly important in recent seasons as the schism between Formula 1 and the FIA has widened.

"All of the drivers have 100% trust and faith in Stefano and FI," said George Russell last month. "We know that they work together with the teams." The Mercedes F1 pilot was talking after the latest in a series of controversies to have erupted, when the unfortunate Carlos Sainz was fined by the FIA for appearing seconds late for a conference. The Williams driver was suffering with a stomach upset and had been detained on the toilet for what Russell wryly termed "an expensive poo!"

Frye joins Rahal Letterman Lanigan Racing

FORMER IndyCar president Jay Frye has made a swift return to the race paddock, joining Rahal Letterman Lanigan Racing as its new team president.

Frye will report directly to team ownership and will oversee operations for the squad's involvement in the NTT IndyCar Series and IMSA WeatherTech SportsCar Championship.

The team also announced that it has parted ways with Steve Eriksen, who had held the role of chief operating officer since January 2023.

"I've known Jay since his arrival on the IndyCar scene in 2013 and have spent a lot of time with him and think highly of his character and his passion for the sport," said team co-owner Bobby Rahal.

"Rahal Letterman Lanigan Racing has a tremendous history of success, both on and off the track," said Frye. "I am very proud to be joining the dedicated and talented team of people at RLL. RLL has the foundation, infrastructure and an incredible commitment to continue being successful well into the future."

ABOVE Former IndyCar president Jay Frye is back in the business

Frye was released in February by IndyCar, with whom a divergence of opinion over the direction of the series' next car was said to be a source of friction.

He weighed an array of offers that ranged from domestic series to Formula 1, but chose RLL as his next destination.

Frye's experience spans over 30 years and includes series and team leadership on both the competition, marketing, sales and ownership sides.

Before he worked in the IndyCar paddock, he enjoyed a successful NASCAR team managerial tenure. He was vice president and general manager for Red Bull Racing's NASCAR team (2008-11) and was named 2008 NASCAR Executive of the Year by ESPN and the Kansas City Star. From 1996-2007, Frye was chief executive officer and general manager of MB2 Motorsports, a team he created and built.

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"Each year, the World Motorsport Symposium brings together a distinguished group of racing experts, each of which is an impactful leader in their field. Their knowledge, insight and transparency on the critical challenges and vision of motorsport make this event essential for industry professionals."

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"The Automotive World is, with each passing year, more and more difficult to predict. The target is well known: Zero CO2; but the way to achieve it on a large scale is dramatically challenging. In such a period, the World Motorsport Symposium, being so open-minded, is very valuable to share and challenge ideas and solutions not just for motorsport, but for motorsport as a lab for future road mobility."

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WHAT THEY SAID...

DR VALERIA LORETI
Delivery Manager Motorsport, Fuels Technology Group, Shell Global Solutions (Deutschland) GmbH

"Participating in WMS 2024 was not only a great opportunity to hear directly from technical experts on a number of relevant and stimulating topics, but also the opportunity for networking and establishing those key relationships that are the basis for further development and exciting breakthrough steps."

DAVID SALTERS
President of Honda Racing Corporation USA (HRC US)

"I really appreciate the effort that goes into the Symposium, the straightforward open discussion, informed debate and reflection."

ERIC JACUZZI
Vice President, Vehicle Performance at NASCAR

"Another great learning experience for the two of us that attended from NASCAR. The topics were very relevant to the future of motorsport, and challenged us to look deeper into some areas of development that we had not previously considered or perhaps considered seriously enough. As always, the collegial atmosphere and lively debates and conversations make for a great event. I am looking forward to seeing everyone again next year and hearing about the advancements another year brings."

ULRICH BARETZKY
Former Director, Audi Motorsport Engine Development, Audi AG

"The 2024 WMS in the famous Royal Automobile Club was very special, a real highlight to mark the event's 20th anniversary. The quality of presentations, as well as the respective discussions in this very special atmosphere, really makes me look forward to the 2025 event."

ALAN PATTERSON
Founder, BeyondMath

"WMS is the one event that brings together all the leaders in motorsport under one roof. As a startup, this is invaluable for us."

SERGE GRISIN
Motorsport Director, Symbio

"I was truly impressed by the quality of the discussions, the insightful exchanges with leading experts in motorsport and technology, the spirit of openness and constructive dialogue, and the overall sense of shaping not only the future of motorsport but also, and more importantly, the future of mobility. A future that aspires to be more sustainable."

MAKING ADVANCES ON SPEED DATA

French IT company Capgemini has joined forces with the works Peugeot WEC squad to enhance the 9X8's performance using Artificial Intelligence. By **Chris Pickering**

BUILDING racing cars is an art. But it's also a science. The distinction between the two comes down to data – predicting, measuring and simulating the car's behaviour.

Even an engineer's intuition is heavily based on things that have shown a measurable benefit in the past; the aero tweak that gave a few extra Newtons of downforce or the calibration change that allowed the driver to eke out an additional lap before refuelling.

Such is the volume of data collected in modern motorsport, from wind tunnel tests to race telemetry, it would be impossible to sift through it all from one track session to the next. For decades, engineers have used traditional mathematics to sort this information – for instance, applying filters to discard momentary spikes or setting thresholds to trigger an alarm when a value goes outside its normal range. With the advent of AI and cloud-based computing, however, there has been a step change in the speed and efficiency of data processing, as well as the tools to uncover previously unseen insights.

"With the tools we have available now, we can put in a list of criteria and search across a whole year's worth of data in one minute online. Previously, it would have taken us several hours to achieve the same thing," comments Emmanuel Ohayon, head of simulation at Stellantis Motorsport.

The Stellantis group has been applying AI to its motorsport activities for a number of years, but things have accelerated recently

Joao Filipe/DPPI

ABOVE The Peugeot 9X8 Hypercars prepare for action in Qatar

thanks to its work with Capgemini. The Paris-based information technology firm has been a technical partner on the Peugeot 9X8 programme since 2022, with the partnership renewed in April 2025.

It takes all sorts

A variety of machine learning techniques, including neural networks based around Long Short-Term Memory (LSTM) and Gated Recurrent Units (GRUs) are employed. The common aim of these tools is to liberate engineers from the process of sorting data so they can focus on decision-making and development, says Ohayon.

"Our speciality is mechanical engineering so the partnership with Capgemini helps because it opens up access to specialist knowledge on data," he explains. "We are limited in terms of resources, so any way we can improve this efficiency allows us to spend more time working on the performance and not just sorting through the data."

> *"With the tools we have now, we can search a whole year's worth of data in one minute"*

Capgemini has established a pipeline to ingest data in different formats taken from different devices, which is then stored on a central cloud platform. The AI models (neural networks) can ▶

Javier Jimenez/DPPI

be trained with this database. We will describe the use of AI models for virtual sensors after in the article.

Even searching for something relatively straightforward can become complex if you have hundreds of gigabytes of data to go through, points out Pierre-Denis Autric, Peugeot 9X8 project director at Capgemini: "When you have hundreds of recordings spread across a season, it takes time just to find and open the files. That's why we've moved to more of a database model. We still record exactly the same data in exactly the same way – in some cases, that is mandated by the organisers – but what's changed is the ability of the engineers to retrieve and analyse that data. For instance, they can immediately compare one incident to another that happened three weeks ago to another car at another track."

Instead of transmitting data from the track back to the factory, it's now sent directly to the cloud. There, it's organised into 'buckets' – groups of related information that are stored together in a database format.

"Our main aim at the moment is to have the ability to extract information really quickly between one session and the next. That's an ongoing topic – we don't always have the bandwidth to do that at the moment," comments Ohayon.

"After that, there's some other work around race strategy. It can be difficult to make the right decision. If you have good information on, say, how the grip will change on the tyres, it can help make the right call. For instance we

LEFT Generative AI is also being used to capture and structure the exchanges and interactions between drivers and race engineers

might want to know how far we will have to reduce the speed to get an extra lap from the same fuel load."

One example is monitoring the powertrain control parameters that are used for the mandatory FIA torque sensors, he notes: "We have to control the power limit very, very accurately. We try to extract some criteria really quickly to show how much margin we have. Another example is tyre temperature information. And there are some key performance indicators that we use for the drivers."

Virtual sensors

The other major application of AI, used on both Peugeot's 9X8 Hypercar and the Formula E car developed by sister brand DS, is to provide virtual sensors. Some types of sensors are forbidden under FIA regulations; others are simply not available in a suitable package for race use. Instead, existing data channels can be used to predict this behaviour – mimicking the function of a physical sensor.

In theory, there's nothing to stop conventional physics models being used to simulate the same behaviour. However, there is not always the full range of data available or the computing power required to do this on the car. For instance, if it's impractical to install a pressure sensor on a certain point on the race engine, the engineers could carry out this work back in the test cell using laboratory equipment then train a neural network to recognise and predict how the pressure reading will correlate with other data channels that are available on the car itself.

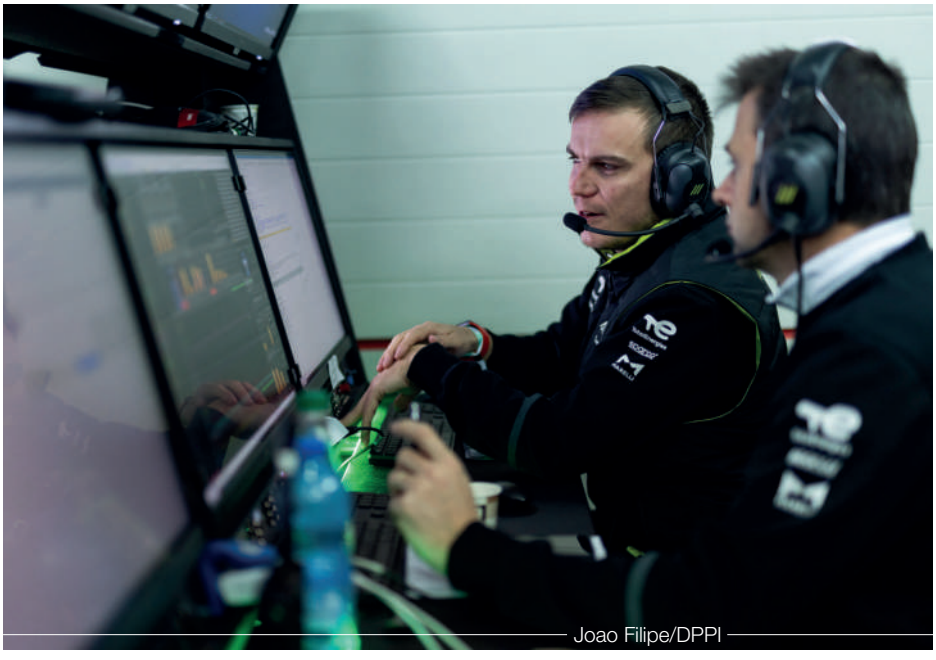
> *"The engineers can now immediately compare one incident to another"*

The process of training these neural networks can take a considerable amount of time and computing power, but the finished models are incredibly processor-efficient, allowing them to be run in real-time in the software integrated in the vehicle control unit (VCU).

"We are condensing what would be a very slow model into something that can run fast enough to transmit data at the same frequency as a normal sensor. That requires a very efficient AI model," comments Autric.

Mathematician George Box's famous observation that 'all models are wrong, but some can be useful' applies particularly strongly to machine learning. These methods essentially work on pattern recognition – learning to spot the relationship ▶

BELOW Peugeot's engineers are reaping the benefits of faster data courtesy of Capgemini


Joao Filipe/DPPI

between inputs and outputs instinctively, rather than rationalising what's happening inside the system. The upside to this is that it can be an order of magnitude faster than simulating the physics, but the downside is that it remains a prediction rather than an absolute certainty.

Ohayon admits he was cautious of machine learning initially. "I am a mechanical engineer, and what I really like is physics," he says. "You have to be careful how you use AI. It's an estimation and it's not possible to say that it's 100 per cent correct, but you can look back at the other data to make sure you have a good level of correlation.

> *"In the future, AI will help us reduce the number of options we need to test"*

"One of the first applications we looked at was on the chassis and we had tried for a long time to do it with physics-based models, but it wasn't easy. When we tried with the neural network, we were really surprised how good it was and how quickly we got the answer. That's not to say we are going to replace all our physics models with AI. I don't want to do that. But I think hybrid AI, where you mix AI and physics models, is a good option."

Ohayon says one of AI's potential uses in the future is to identify promising configurations that can then be evaluated with track testing.

"With all the data we have collected since the beginning of the car, we think we will be able to use it to identify some optimal configurations to test. That is really important when you have limited test sessions. I think, in the future, AI will help us ▶

Joao Filipe/DPPI

ABOVE Mikkel Jensen prepares for a stint in the Peugeot 9X8

BELOW Capgemini has been supporting Peugeot with decarbonisation, helping the team win the FIA WEC DHL Sustainability Endurance Award at Bahrain in 2023

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to reduce the number of options we need to test. If you have only one day of track testing for a six-month period, you have to be really careful about what you choose to test."

As a general rule, the closer the scenario is to existing data held in the cloud, the more representative the results will be, but that doesn't stop information from previous events coming into play.

"It can be really interesting when we compare to the same event the previous year. That's often not possible with traditional techniques as it would take too much time to find the data, but with the new AI tools we have, we can make a comparison very quickly. For example, we might want to compare the set-up, sector times, the power that we're using or the tyre temperatures. That's assuming that the car has not really changed. If it's completely new or if you've had big evolutions then it's not possible to compare," says Ohayon.

Future plans

Now in its third season of competition, the Peugeot 9X8 received a substantial update last year, with a new aero package and new tyre sizes. A joker update for the start of this season has brought further revisions to the front and rear suspension. Were these changes influenced by the use of AI?

"A little," says Ohayon. "AI is not something that we're currently using in the design process, but it is something that has helped in the analysis of the behaviour of the car."

While the main uses of AI in the team at the moment are data analysis and virtual sensor channels, there are other applications that are being actively pursued. One of these is the concept of predictive maintenance. This is similar to the approach used in the aerospace industry, where experience has shown the early signs of failure aren't always as obvious as you might expect. For instance, a minor pressure fluctuation at the front of ▶

ABOVE The Peugeot engineers during the 6 Hours of Imola

BELOW Mechanics at work on the 9X8 Hypercar in Qatar

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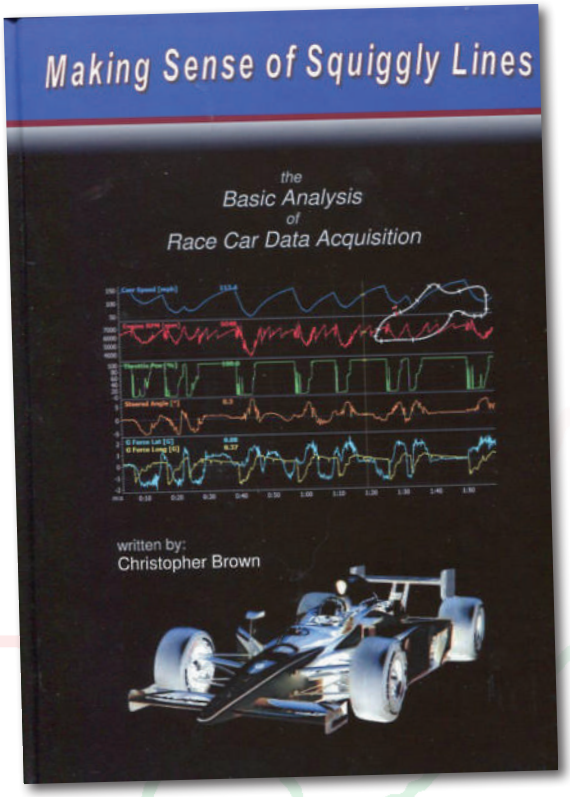

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a jet engine might hint at a turbine blade that needs replacing at the back. AI's ability to identify patterns in the relationship between seemingly unrelated variables can make it a powerful tool in unlocking these insights.

"These cars are prototypes. They are not completely industrialised, and they can have noises and unexpected quirks. There is a lot of interpretation to understand if that's normal behaviour or not. We can use analysis tools to check all the data from the car, make sure they are in the normal range and to identify if something suggests there is a risk of failure in the future. It may be that you have 1,000km left on the rebuild life of the engine, but because of the behaviour that you're seeing, maybe it is safer to change it now," says Autric.

> *"It will always come down to the engineer to make the decision"*

George Powell

All talk

Another area that the 9X8 team are looking into for the future is the use of large language models (LLMs) to follow the conversations between the engineers and the drivers.

"At the moment, we're very focused on structured data. You might have a large number of sensor channels, but you know what each sensor is reading, how often it samples and so on. But that's not the only data we are able to capture. We have the conversations between the drivers and the engineers. For instance, the driver might say 'I'm starting to lose front-end grip' at a certain point on the track. We want to see if we can use generative AI to capture that information and transform it into a more structured form that we can use for analysis," Autric explains.

It's already common practice to record the radio

ABOVE & BELOW Capgemini played a central role in delivering the 2023 Rugby World Cup, with its ambassador Jonny Wilkinson

RIGHT The simulator at Peugeot's headquarters

BELOW The Peugeot 9X8 Hypercars chase each other round Imola at April's WEC race

conversations, but currently they are simply stored as sound files. If an engineer wants to search through with statistical tools, it needs to be tagged and categorised, Autric notes.

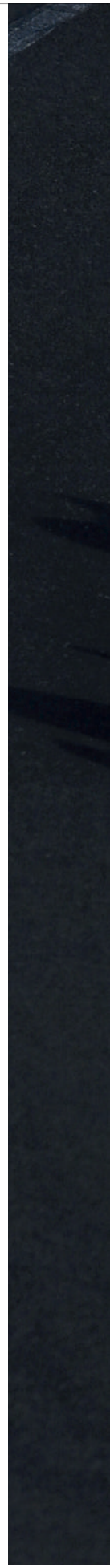
Is this the beginning of the end for the human race engineer? Predictably, not.

"We want to have the best information available, and we want it there when we need it, but it will always come down to the engineer to make the decision," comments Ohayon.

However good the computers become at the science, it seems that it will remain the job of humans to bring the spark of inspiration that elevates it into an art form. RT

Fabrizio Boldoni/DPPI

KNOW YOUR *LIMITS*



RIGHT With IRK's technology, the days of pushing Formula 1 track limits could soon be over

Infrared Kinetics has developed a revolutionary three-dimensional object tracking system that could have big implications for motorsport, gaming and much more – as **Chris Pickering** discovers

ONE thing, perhaps more than any other, defines circuit racing. Ultimately, it's all about track position – whether that's crossing the line first as the chequered flag falls or positioning your car defensively to deny other drivers that opportunity.

The cat and mouse battles that unfold throughout the race are just as likely to delight fans as the final result; one car edging ahead of another or perhaps two locked side-by-side like Villeneuve and Arnoux's famous battle at Dijon in 1979.

None of this means anything without a degree of fairness and at least some adherence to track limits. Safety considerations at modern circuits mean that it's not generally feasible to put crash barriers or high kerbs in to deter drivers from choosing their own path, so it falls to the race officials to police these matters.

Formula 1 uses a complex combination of pressure transducers embedded in the kerbs, laser sensors, AI analysis of video footage and good old-fashioned human judgement. Nonetheless, it can be a time-consuming and laborious process. This year in Bahrain Nico Hulkenberg knocked Alex Albon out of Q1 with a lap time that was later deleted for track limits violation, directly impacting the competitive integrity of the race.

At the Austrian Grand Prix in 2023 – admittedly before the introduction of the new AI system – it took the stewards five hours to review all the potential infringements and declare the official result.

Think about that for a second. This is the fastest and most technologically advanced race series on the planet, and many of the fans had driven home and eaten dinner before they knew for sure where their favourite drivers had finished. And that's at the very peak of the sport. For lower-level categories and smaller venues the options are far more limited.

Infrared Kinetics (also known as IRK) believes it has a solution – and it has trialled it not at a glitzy new 21st century racetrack like Abu Dhabi, but in the more rural surroundings of Mallory Park in Leicestershire. As such this favourite among British club racers can lay claim to the title of the world's first fully digitised racetrack.

The system used at Mallory is the brainchild of Professor Andrew Bradley. An aerospace and defence industry expert, his previous work includes a stint as the chief engineer for the Hawk advanced trainer aircraft. He stepped down from his full-time role at IRK in 2022, but remains heavily involved as an independent consultant. Other key figures include former Donington Park CEO Christopher Tate and ex-F1 team owner and former BAe director Lord Hesketh. Computing specialist Dell Technologies and defence contractor Roke Manor Research are partners in the project.

"We started off by asking, what could we do if we took the infrared search and track (IRST) sensor from a Eurofighter Typhoon and suspended that from something like the famous Goodyear Blimp looking down at a circuit. If we had one very big, very high resolution camera like that, could we track multiple cars, just using the thermal signature from the tyres?" recalls Bradley.

The idea progressed in its planning from a single giant camera to a series of tethered drones, then finally a network of cameras mounted on masts around the circuit. Instead of relying on the car's own infrared signature, the system now uses small infrared beacons mounted on the top of the car – typically two on each car to provide both the direction and orientation of the vehicle at any given moment.

Fast thinking

The cameras are a cheap and well-proven technology, similar to the cameras used in modern phones. Mallory Park has nearly 90 of these devices providing full, uninterrupted coverage of the 1.4-mile circuit and associated areas such as the ▶

Getty Images/Red Bull Content Pool

pit lane and run-off areas.

A novel combination of traditional surveying techniques and drone photogrammetry has been used to build up a highly detailed 3D map of the circuit, including the position of each of the cameras. By combining this with its view of the beacons, the system is able to determine accurately the position and orientation of each car, even though it's only visible to a single camera. Differentiating this with respect to time gives the velocity and acceleration, while some simple geometry can be used to give the precise location of the vehicle's extremities or its four tyre contact patches.

The cameras can track the emitters in the beacons at 90Hz with less than 5 milliseconds of latency. This speed, combined with the extremely broad field of view provided by fusing the imagery from all 90 cameras, means that the system can generally identify each car purely by tracking its location over time. Initial testing has shown this approach to work – certainly with a limited number of vehicles on the track – but the team is currently developing a new beacon design that will emit a unique ID code for each car, eliminating any risk of confusion if multiple sources overlap.

In theory, it's a relatively simple variation on the optical tracking systems that have been used in other industries for decades. Live action motion capture – such as Andy Serkis' portrayal of Gollum in the *Lord of the Rings* movies – relies on a similar principle, as does the Hawk-Eye system used to track the ball in major sporting matches. However, there are some significant differences.

"In a tennis match, you've only got one ball to track in an area the size of a tennis court, and it doesn't matter if it takes a few seconds to process the information. The real challenge here is that we've got 30 cars spread across something the length of a race circuit and we want to sample that 90 times a second continuously," notes Bradley.

The main way that this is achieved is to simplify the image processing. Using narrow band infrared naturally filters out much of the signal noise that would otherwise have to be

LEFT The beacon can be fitted on top of any racing car

RIGHT Mallory Park is the unlikely centre of motorsport's latest digital revolution

LEFT IRK's beacon fits into a canopy the size of a grapefruit

> *"Mallory Park can lay claim to the title of the world's first fully digitised racetrack"*

removed. A proprietary system has been developed to synchronise all the beacons and the cameras – the exact details of how this works remain confidential, but it's understood to have required careful attention to the design of the hardware.

Another important part of the philosophy is to distribute the processing power, with each cluster of cameras having its own processing unit. This minimises the amount of data that needs to be transmitted across the network.

Harry Uzzell, deputy head of engineering for AI/ML and data science at Roke, explains: "We've got a gigabit fibre optic network ring running around the poles at Mallory but we don't make use of anywhere near that bandwidth because we do all the image processing locally then we just send back the location of each beacon to a central node. It's that central node that combines that data into a single world view."

Real world problems

One of the biggest challenges has been to implement the system outdoors, away from the relatively controlled environment of a film studio or a sports stadium.

"We have to deal with all of the practical challenges that you get in the real world," adds Uzzell. "It's things like the wind causing the poles to sway or birds landing on them. Also, the system needs to be scalable. Mallory is a small track – about a third of the length of the grand prix layout at Silverstone – but this is the first time anyone has tried something at this sort of scale. We've designed some overlap between neighbouring sensors to ensure that we never lose sight of a car between them."

The weather has played a factor – particularly in the wilds of Leicestershire – but not always in the way that the team ▶

Images: Infrared Kinetics

> *"The system can identify each car purely by tracking its location over time"*

expected. Infrared has been shown to perform better than visible light in rain and fog, but sunny weather has proved more challenging. The engineers had already factored in background radiation on warm days, but it was the glint and glare from a wet track, especially when combined with low winter sun, that proved the greatest challenge.

"The winter has taught us a lot. It creates lots of things that look exactly like our emitters and exactly like a stationary vehicle," comments Uzzell. "But that's where the intelligence comes in. We know we're looking for a pair of beacons that are a known distance from each other and within a known range from the camera. The ID system works by pulsing the beacons at varying signal strengths, so we can use that to distinguish them from optical effects like glare. And the other tool we have is that we can look back and reference each car's previous position."

Even when the cars are moving very fast, they don't move that far. At 200mph, a car travels just under one metre in the ninetieth of a second between one frame and the next. And that's linear velocity. Lateral movement across the track – for instance, moving off-line to overtake an opponent – happens far more slowly.

"Things get more complicated when cars behave in a non-linear fashion," Uzzell admits. "For instance, if they stop, they spin or they crash. Any sort of tracker will struggle with something that can go from 200mph to stationary in a very short space of time. We've learnt a lot about how to model the unique behaviours you get with racing cars, but on top of that we're now implementing the ID tagging system. So, if two cars were to go off the track into a part of the run-off area that was obscured by a tree, say, we could still tell which is which when they return."

These are challenges shared with other mainstream applications such as road transport and autonomous vehicles. Bradley points out that one of the original ideas was to install sensors for public highways on lampposts to provide a large-scale network for self-driving vehicles. While the speeds are far lower on the roads, the system would have to deal with traffic jams, vehicle breakdowns and extreme weather conditions. It also means that the hardware would ▶

ABOVE IRK's technology could have real world applications including autonomous driving

BELOW One of IRK's cameras in action at Mallory Park

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need to be cost-effective enough to scale up coverage to a much larger geographical area.

"One of the reasons that we chose motorsport for the first application of this technology is that it's a great proving ground," notes Bradley. "If you can track something at 220mph on a race circuit, you can certainly track it down the M6 at 70mph. We don't have people actively competing against each other and swerving around quite so much there. The other thing is that we can book the track for a day and we can test any scenario we want. We can have the cars going around clockwise in the morning and then, for the purposes of the test, we could send them around anti-clockwise in the afternoon."

The system has been tested successfully with three cars on the track and the next step is to carry out a simulated race with a larger field, says Uzzell. Essentially, though, he believes the technology is ready to go.

"We're now in a position where we could begin to deploy this on another circuit, and that's something we're very keen to do," he insists. "The only thing that's really left in terms of development is that we would need to do some work on miniaturising the emitters if they were to be used in something like Formula 1, where size and weight are very critical."

The existing beacons occupy a domed shell roughly the size of a grapefruit. However, these accommodate things like a battery power supply and their own clock for synchronisation. Uzzell says a vehicle-specific installation, integrated with a stable onboard voltage supply and an existing suitable timing signature could be significantly smaller.

RIGHT This innovation could lead to racing paradise for e-racers

BELOW Is the Holy Grail of gaming – to be able to virtually race the entire F1 field – within reach?

Getty Images/Red Bull Content Pool

e-sports potential

IRK's software effectively generates a digital twin of the circuit, complete with the speed and location of all the cars on it at every given moment. This has obvious implications for track limits enforcement, but it could also be applied for circuit management, scoring and safety. You'd know immediately, for instance, if a car had left the circuit and potentially suffered an accident or a mechanical failure.

But the greatest opportunities may be found elsewhere, according to Uzzell: "Having an accurate real-time map of the activity on the circuit opens up the possibility of immersive and viewer-controlled race viewing. With the tracking information, you can generate a virtual feed. For instance, you can follow the cars in real-time as if you were piloting a drone alongside them. That would allow fans to follow a specific driver that they support. Or you can be sat in the grandstand with a view of one part of the track and have an app that you control to show you what's happening over the other side of the circuit."

Patrick Gosling

> *"This technology could allow gamers to become the 21st car on the F1 grid"*

The IRK team is particularly excited about the potential to blend real world events with e-sports. High accuracy and low latency would allow gamers to add their virtual cars to a digital representation of the race in real-time – effectively meaning they could become the 21st car on the F1 grid. The same technology could potentially allow track day enthusiasts or club racers to compete against their own real-world laps in simulation.

Creating a full-scale digital map of the track could even open up a revenue stream for circuit owners to license that IP for gaming, immersive viewing or engineering simulation. Similarly, Bradley believes this location data could be used by race teams.

"When we spoke to Formula 1 engineers they've told us a precise car positioning technology – something that can provide much greater accuracy than systems like GPS – is a key priority. They know to the millisecond when a driver has pressed the brake pedal, but the location of that braking point could be 10 metres out," says Uzzell.

The control tower at Mallory Park now has three sim rigs installed. A prototype gaming environment has been developed using Unreal Engine and the team has already 'raced' virtual cars against the test vehicles in real time.

Bradley, incidentally, is no stranger to the world of gaming. Alongside his day job at British Aerospace – later BAe Systems – he wrote a series of successful videogames in the 1980s, including *Grand Prix Construction Set* for the BBC Micro and *Scalextric: The Computer Edition* for the Sinclair Spectrum, Amstrad CPC and Commodore 64.

With the explosion of interest in e-sports it's possible that this could turn out to be one of the most valuable applications of IRK's real-time tracking technology. However, its creators believe that this system could offer something for everyone, including better data for drivers and engineers, a more immersive experience for racing fans and a potential revenue stream for circuit owners and promoters. RT

SEAT OF LEARNING

Anthony Peacock blows the sand off the FIA's all-new Seat Attenuator, designed to reduce the likelihood of back injuries in Rally Raid

IT'S famous for being the harshest, most endurance-focused, and elemental form of motorsport in the world: where crews either conquer the natural world or suffer the endless blows that nature can mercilessly inflict on them.

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There's rarely such a thing as a small accident when it all goes wrong. With the high speeds and massive jumps that are a hallmark of the discipline, many shunts on the Dakar Rally – the highlight of the series – are described as being similar to a plane crash.

That's why, with funding support from the FIA Foundation, the FIA has recently introduced its Seat Attenuator, adding another level of protection to how rally raids protect their most valuable assets: the drivers and co-drivers.

Kin Marcin/Red Bull Content Pool

BELOW Nasser Al Attiyah's Dacia Sandriders tested the FIA Seat Attenuator during their victory at October's Rallye du Maroc

For decades, motorsport has accepted a certain level of physical trauma as the cost of competition, especially in the world of cross-country rallying. Spinal compression injuries have inflicted pain and suffering on some of the most celebrated names on the Dakar, with the many examples including four-time Dakar winner Carlos Sainz in 2023 and co-driving legend Daniel Elena in 2018.

But, as FIA Safety Director Nuno Costa explains, there wasn't just one particular incident that triggered the need to do something. Instead it was a general trend of spinal injury seen over many years.

When Cross Country cars land after those huge jumps, the immense suspension travel of 350mm can only do so much. When it bottoms out, the next line of defence is the seat padding. Then, the human spine absorbs whatever energy remains.

Crash course

"But these impacts are extremely complex," adds Costa "So we needed data to properly understand what was happening. We started off by installing an accident data recorder, similar to a black box on an aircraft, back in 2016."

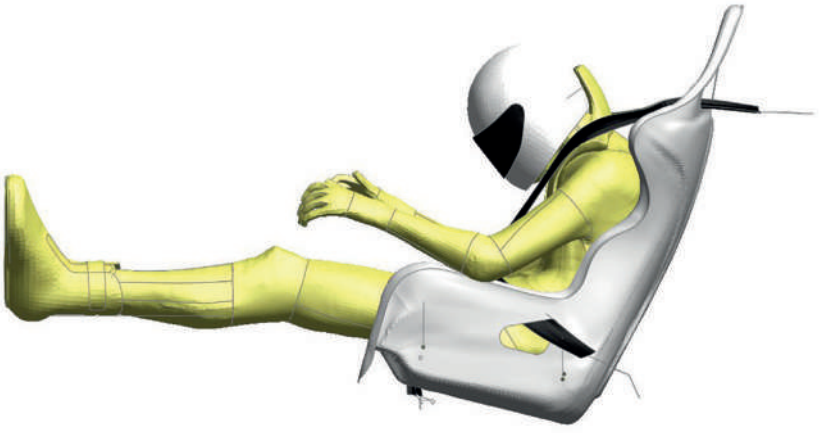
These black boxes enhanced another of the FIA's most powerful tools when it comes to improving safety: the World Accident Database, inaugurated in 2015. With data fed from every corner of global motorsport via ASNs (national motorsport authorities), a picture gradually emerged of impact angles, g-forces, crash pulses and injury outcomes.

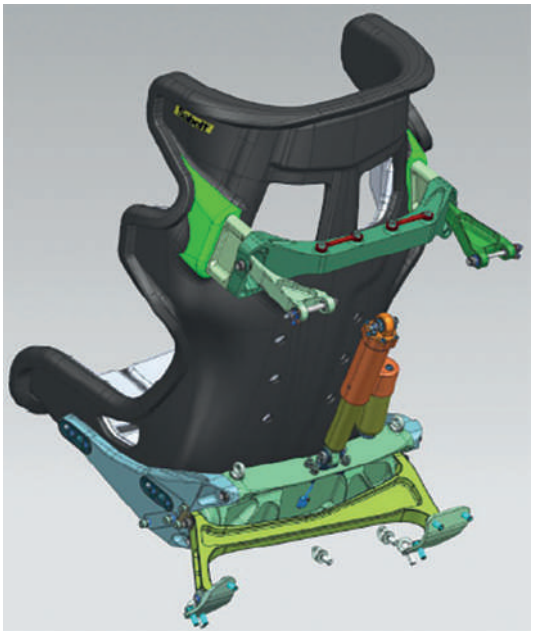
> *"In rally raid there's rarely a small accident when it all goes wrong"*

Using all these general data sources, the spinal injury puzzle in Cross Country rallying began to gradually come into focus. As Costa points out, it was important to properly understand the problem before finding a solution. Prior to any hardware being built, the FIA Research and Vehicle Safety team leaned heavily on numerical modelling and human injury biomechanics simulations. For this project the FIA used Madymo, LSDYNA and THUMS. The goal was to define how much vertical deceleration the spine can tolerate, and then engineer a seat to keep forces below that threshold.

Armed with crash pulse data, the FIA went to work with crash test dummies to further isolate the load thresholds where the spine becomes vulnerable.

The key culprit was vertical deceleration exceeding 40g, at impact angles of around 58 degrees. In ▶





ABOVE & LEFT CAD imagery from the Seat Attenuator's development

RIGHT The FIA Seat Attenuator undergoes testing at a range of impact angles

other words, the sort of heavy jump landing that fans love and drivers dread.

The scale of the issue sparked a radical rethink of traditional cockpit architecture. What if the seat could move? Not just flex, but actively absorb, dampen, and redistribute all that brutal energy away from the spine?

The definitive answer was partially inspired by other industries, including offshore powerboat racing, aerospace, and – more prosaically – commercial trucking.

These contexts have long since confronted similar problems: big vertical shocks and the need to keep their occupants fully functional afterwards.

After a lengthy period of study, the FIA moved towards the concept of 'decoupling' the seat from the car – the real area of innovation, according to Costa – allowing it to move independently from the chassis under specific conditions.

Traditional safety cell design has always hinged on rigidity: reinforcement, structural integrity, tight packaging. The seat attenuator flipped that idea on its head. It introduced compliance within the cockpit, accepting that something will give, but in a predictable, controllable, and non-destructive way: so that the crew experiences less deceleration than the car and can keep going afterwards.

On its own, this is nothing new in engineering. Crumple zones work on the same principle. But these are just 'one shot' safety devices. The seat attenuator had to be a multi-use solution.

The result was a seat mounted not rigidly to the chassis as usual, but instead suspended via a specially-engineered damper system. These dampers are tied into the roll cage rather than the floor to maintain structural integrity and ensure predictable load paths.

Emergency use only

In the event of a high-impact landing, the damper compresses along a stroke of approximately 100mm, soaking up a lot of the energy before it ever reaches the driver's spine. Crucially, it's not active all the time. For the most part it feels exactly like a normal racing seat; allowing the driver to have that all-important seat-of-the-pants connection to the way that a car is moving. The attenuator is calibrated to engage only above 12G: the threshold identified in data where injuries begin to spike, normally on a hard landing.

The system is directionally sensitive too. It allows smooth compression but avoids a vicious rebound, in order not to accelerate occupants back upwards like a reverse bungee after the impact. The end result is remarkably stable progress.

The FIA is quick to point out that this is about safety rather than comfort, but there's an important side benefit, with crews feeling less fatigued over long stages. Another plus point is better driver performance through increased confidence. Each time the crew touches down after flying off a crest, they won't be physically and mentally bracing themselves. This should encourage drivers to push harder – with fans perhaps benefiting from action that looks even more externally spectacular. The new attenuator doesn't absorb just shock – but also fear.

> *"What if the seat could redistribute all that brutal energy away from the spine?"*

With the basic concept nailed down, the FIA presented it to all the Cross-Country manufacturers during Technical Working Groups. As Prodrive believed in the concept, they designed their own system to comply with the FIA regulations. The prototype made its competitive debut at the Rallye du Maroc last October, fitted to Prodrive's Dacia Sandrider T1+ machine: an ideal open air laboratory. Nasser Al-Attiyah duly won ahead of his Davia team-mate Sébastien Loeb. The third-placed driver was more than eight minutes down the road.

Before the deployment in the first event, the system was validated with a full-scale dynamic sled test aimed ▶

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at replicating a severe crash pulse scenario. What they found was nothing short of transformational: the Seat Attenuator reduced the peak force transmitted to the driver's spine by up to 50 percent. Rather than just an incremental gain, this was a game-changer.

Old school engineering

According to the FIA, the attenuator project took about two and a half years to come to fruition, from initial concept to prototype, although the majority of the work happened in the last 10 months before Morocco. Interestingly, while artificial intelligence is on the FIA's radar, AI played no role in its development. This was pure, traditional engineering: humans, data, simulations, test rigs and prototypes.

But it wasn't just a question of designing an effective damper, as the knock-on effect over the rest of the car was considerable. The system also required a newly homologated competition seat and seat belt structure, in collaboration with Sabelt.

With data in hand and validation confirmed, the FIA has moved toward regulation – but not in the traditional top-down manner. Instead, the Federation has invited manufacturers into the design process: recognising how fiercely protective they all are of weight and space.

"The biggest challenge has been to find the right compromise with the manufacturers," adds Costa. "Weight and space is not something they give away for free in motorsport. And of course a lot of their input is needed, as the cockpit needs to be ▶

> *"The attenuator is calibrated to engage only in impacts above 12G"*

ABOVE The FIA Seat Attenuator has the potential to be used in other off-road categories

BELOW Off-Road competitors like Loren Healy face more extreme conditions than most, increasing the load on drivers' backs

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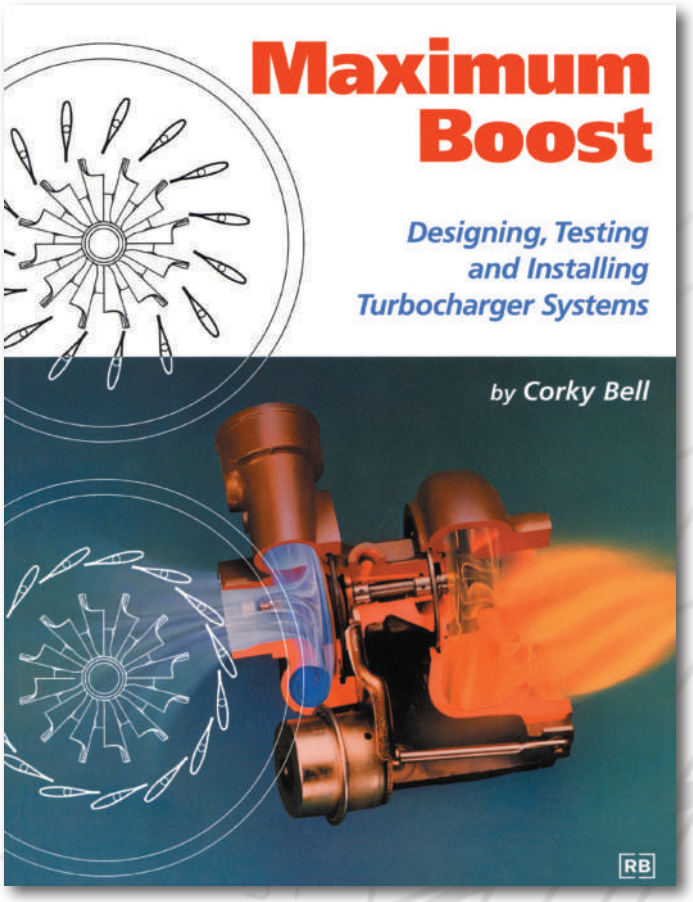

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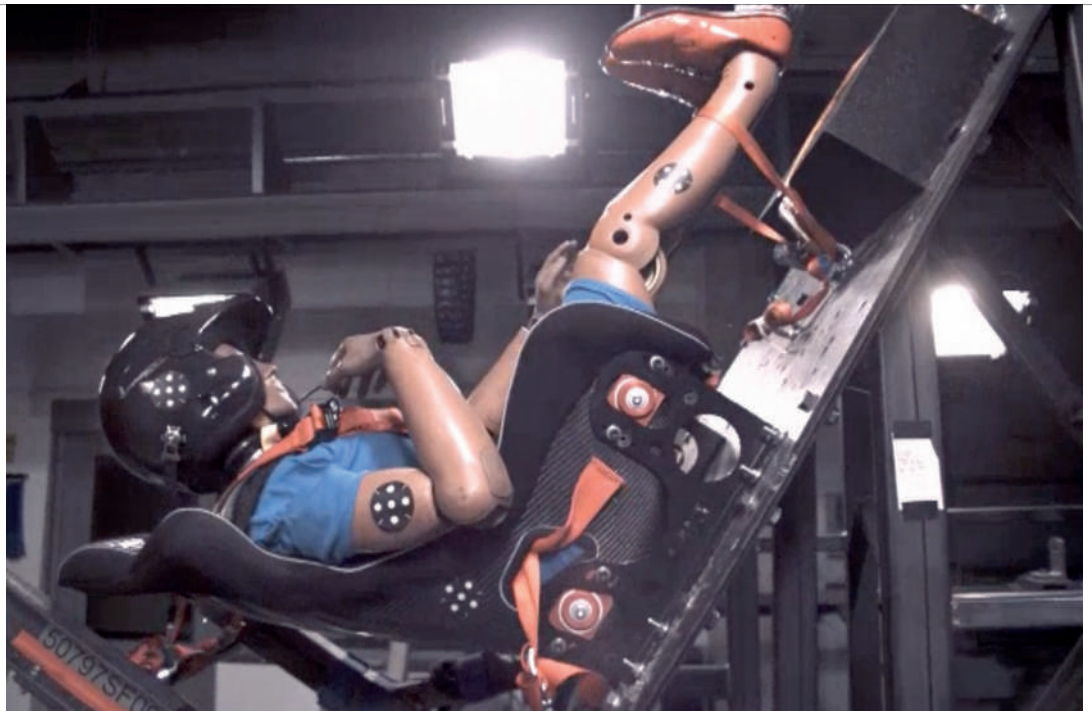


LEFT & BELOW LEFT Progress with the FIA Seat Attenuator – shown in R&D – accelerated during 2024

BELOW The FIA Seat Attenuator has potential to spread throughout motorsport, notably to the likes of Thierry Neuville in the WRC

redesigned to accommodate the system, especially with space needed under the seats for the damper."

Every gram added to the cockpit, every millimetre lost beneath the seat, is a potential performance penalty – so some resistance was to be expected. However, the FIA want to give manufacturers every engineering opportunity to lessen the penalty without compromising safety.

The result is what can be described as a flexible regulatory framework. While the technology will be mandatory from the start of 2027 for all newly homologated T1+ cars in W2RC, each manufacturer will be allowed to build their own version of the system, provided it meets the FIA's dampening performance criteria.

This open approach mirrors the collaborative ethos that defined the whole project. The FIA's research and strategy working group, closed roads commission and safety committee also provided feedback, as did the various technical working groups. While no drivers were directly involved in the development, the FIA maintains an ongoing dialogue with a panel of W2RC competitors to inform future refinements and has drivers' representatives on several of its governance bodies.

This won't be a sweeping change but a gradual one. Existing cars will still be able to run in their current configuration after January 1, 2027, as this is not a system that can be easily retrofitted (mainly due to the space required under the seats). The

> *"The implications will ripple across global motorsport"*

intention, however, is to eventually cascade this system down through every level of Cross Country rallying, all the way to the grass roots.

The implications will ripple across global motorsport. Other series are watching – the WRC in particular, and there's an obvious application to Extreme E as well – but the key focus has always been Cross Country: simply because that's where the spinal injury data and weakness lies.

Marco Petrilli, Deputy to the Safety Director and Head of Research and Vehicle Safety at the FIA, says: "This has been a really fantastic project to bring to the W2RC. In everything we do at the FIA, we are driven by the data, so we identified this discipline specifically as an area where we could bring significant benefits for the crews. And if in future manufacturers find some different ideas to Prodrive's in order to achieve this, we are very happy to work with them to validate their solutions."

Weight and see

That's why it's quite hard to quantify for now how much the system will eventually weigh: it all depends on the solutions and integration methods that are finally adopted.

The FIA Seat Attenuator doesn't change what rally raid is, as from the outside it's invisible. But it may just redefine the very boundaries of endurance rallying in future.

The most profound innovations in motorsport often go unnoticed by fans, but they still win time. Not only on a special stage, but time added to a competitor's career, years spared from injury, and confidence to push that little bit harder – perhaps giving a second chance to win that didn't exist before.

The FIA Seat Attenuator is one of those innovations: a purpose-built, data-driven piece of ingenuity that answers a real and previously unsolved problem in motorsport.

Every time a crew touches down after defying gravity, this quiet bit of tech will help absorb the price of their audacity; ensuring that the thrill of fight and flight doesn't come at the cost of lifelong injury.

Jaanus Ree/Red Bull Content Pool

BRAKING THE CYCLE

American brake specialist PFC tells **Chris Pickering** how the introduction of hybrid power has changed the emphasis of its IndyCar brake system

THE last thing an IndyCar driver wants to do as they approach the Indianapolis banking at 230mph is to touch the brakes. In theory, they could go for 35 laps without even brushing the pedal at the historic 2.5-mile track.

But, eventually, fuel and tyre usage will force them to dive into the pit road. At that point, discs and pads that have sat dormant for laps on end will have to haul the car down to a standstill for a 7-second pit stop that could determine the outcome of the biggest prize in motor racing. No pressure then.

At four miles a minute, the laws of physics weigh heavily on a car. Any sources of unnecessary drag are ruthlessly eliminated from the braking system, which uses a pad retraction device to minimise contact on the surface of the disc. A tiny amount of residual drag – caused in part by the deflection in the brake and hub assembly when it's subjected to nearly 5G of lateral load – is just enough to retain maybe 40°C in the discs. Colder than a typical road car.

As the driver hits the brakes, that soars to around 500°C for a few seconds. And then they're dormant again – aside from the odd yellow flag or wayward backmarker – for another 35 laps before the whole process is repeated again.

It's a brutal enough duty cycle in isolation, but the spec IndyCar brake package also has to cope with street circuits like Detroit, where more than a third of the lap is spent hard on the brakes, and road courses like Mid Ohio, where the brake temperature peaks at more than 930°C on a typical lap. There are higher performing brake packages out there, but none that have to deal with such a bewildering array of different conditions.

This year, the teams lining up for the Indy 500 will face a new challenge. While hybrid systems were ▶

> *"As the driver hits the brakes, their temperature soars to around 500°C for a few seconds"*

RIGHT The Indianapolis pit lane – shown at April's test – is the circuit's primary braking zone

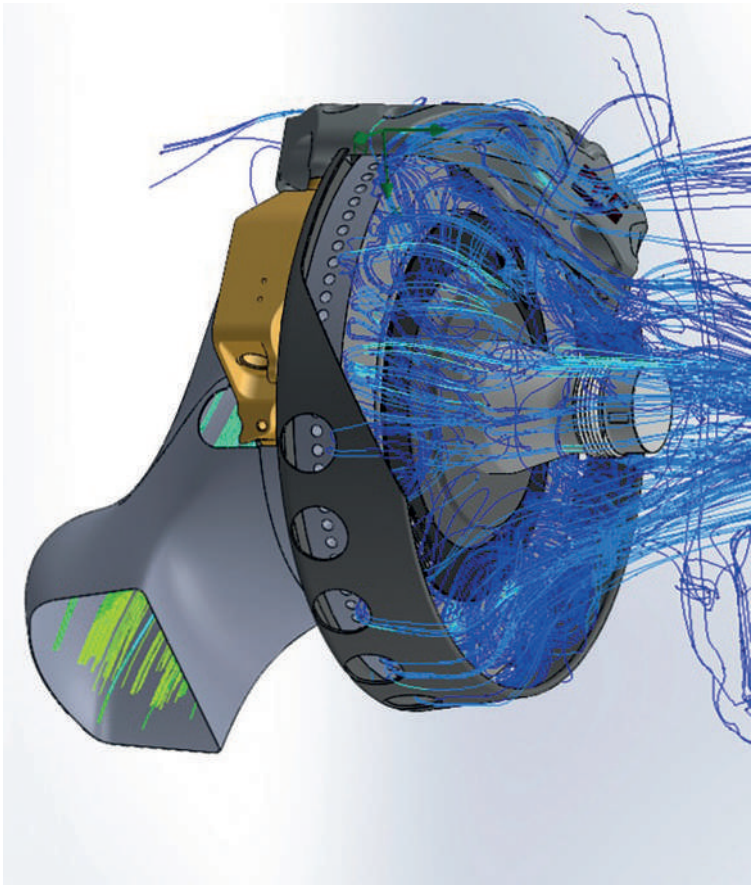
Joe Skibinski

introduced to IndyCar in 2024, they didn't arrive until Mid Ohio in July. This month will be the first time that hybrid systems have been used in The World's Greatest Race.

The current brake hardware arrived at the start of 2024 and is correspondingly known as the 24 Package. It marks the latest step in a process of evolution that began in 2017, when the series transitioned over to Performance Friction (PFC) pads and discs while still using the old Brembo calipers.

For 2018, a full PFC brake package was introduced, including new hats and calipers. A series of revisions to the spec Dallara DW12 IndyCar followed, with

BELOW The CFD of the latest braking system from PFC



standardised aero kits in 2019 and the wraparound Aeroscreen cockpit protection system in 2020, which added weight to the car. This meant that the 18 Package was approaching the upper limit of its operating temperature. Conscious that the hybrid system would bring more weight as well as more power, the PFC engineers prioritised greater thermal capacity and improved cooling for the new brake package, originally slated for 2020. The Covid pandemic and subsequent delays to the introduction of the hybrid systems meant the finalised package would not compete until 2024, and it has been carried over unchanged into this year.

"With the 24 Package we were looking at how we could improve the cooling and the thermal mass

> *"This will be the first time hybrid systems have been used in The World's Greatest Race"*

while still accommodating that inside the existing caliper," explains James Borner, technical programme manager at PFC. "We were able to increase the sweep by 4mm, then we used a lot of CFD and thermal simulation to decide what to do with the disc cooling and hole packages."

Originally, a blow through configuration was used, where the hat attached to the middle of the rotor, with cooling channels used to feed air through the hat and into the disc. For the 24 Package, this was replaced by a more conventional outboard cooling approach as it was found to be more efficient for the increased thermal needs of the revised car. This, in turn, led to more cooling holes being drilled in the disc, with a radial pattern that provides a greater pumping effect through the core of the disc, improving the distribution of cooling flow.

"We were targeting a 150-200°C peak temperature reduction, which was supported by the early testing at Sebring, where we had cars ballasted to the hybrid weight," recalls Borner. "Once the carbon goes over 650°C the material that's in direct contact with the air oxidises into carbon dioxide and you lose mass from the disc. That, in turn, accelerates the abrasive wear as you open up the porosity of the disc.

"We can see instantaneous peaks of more than 1,000°C. That in itself is not problematic but the crucial thing is the combined time spent at more than 650°C. That's what we were trying to address with the 24 Package. Bringing down the average peak temperatures reduces the wear."

The teams have to use a spec external design for brake ducts, but they can modify the internal design and the level of blockage. Even with the ducts fully open, the old brake package was hitting well over 650°C for extended periods, but the 24 Package runs significantly cooler.

"Our material is fairly forgiving and can generate decent mu numbers at low temperatures, but the sweet spot starts at about 450°C," explains Borner. "It's not just a straight friction map – it varies based on contact pressures and temperature profiles."

Even without any additional cooling, the brake temperatures can drop well below their sweet spot at Indianapolis, but it doesn't take long at all to build heat when the driver hits the brakes at 220mph.

Five years ago there was a vivid demonstration of just how easy it is to build heat at these speeds. A fault thought to have been caused by a pinched or kinked brake pipe caused the front brakes to drag slightly on

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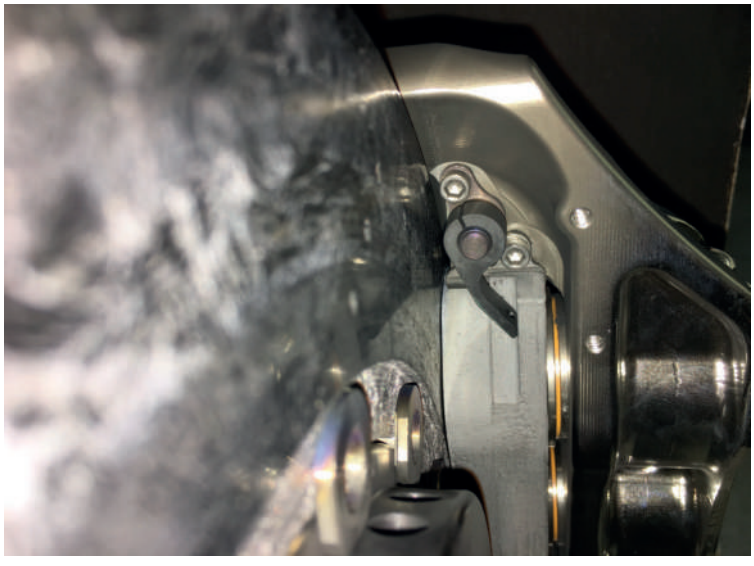
ABOVE The PFC brakes exposed on Felix Rosenqvist's Arrow McLaren

James Davison's Honda. Within a couple of laps the discs were glowing white hot. PFC estimates that they reached more than 1,500°C before the magnesium alloy of the front right wheel caught fire and brought an end to the Australian's race.

Double whammy

The hybrid system effectively introduced a double whammy, with more powerful cars that entered the braking zone faster, but then had to decelerate further as a result of lower cornering speeds due to the increased mass. The effects of this can be seen to different degrees on the four distinct types of circuits used by IndyCar: purpose-built road courses, temporary street circuits, short ovals and the super speedway at Indianapolis.

BELOW IndyCar brakes feature a pad retraction device to minimise contact on the surface of the disc



Long Beach and Road America are two of the toughest circuits on the calendar in terms of deceleration requirements. While Long Beach is far shorter and far tighter overall, they both share long main straights going into big braking zones. The average braking deceleration on both tracks reaches 3.5G, but the drivers spend almost twice as much of the lap on the brakes at Long Beach (28 per cent) as opposed to Road America (16 per cent).

Thanks to its high speeds, however, Road America tops the list for the highest average brake energy per lap at 6.5kWh (calculated by determining the change in kinetic energy over the braking zone and then integrating that against time, with an adjustment factor applied to allow for other contributing factors like aerodynamic drag).

As any physics student will tell you, kinetic energy follows a square law ($\frac{1}{2}MV^2$) so although the drivers actually spend a greater percentage of the lap on the brakes at Long Beach, the lower average speeds put it towards the bottom of the table at 4.6kWh for the average lap. The lowest, incidentally, is St Petersburg on 3.4kWh, with Detroit not far behind on 3.8kWh even though it has the greatest percentage of the lap spent on the brakes (34 per cent).

The overall assemblies for the 24 Package and ▶

its predecessor weigh around the same amount. However, the older assembly featured a slightly heavier hat combined with a lighter disc (resulting in a lower thermal mass). Most teams had a considerable collection of unused parts, so they were allowed to choose which package they ran at each race in 2024.

For ovals and the less brake-intensive road courses, the race engineers quickly worked out that there was a benefit to sticking with the old package, because the overall mass would be lower once the disc started to wear. It was only the heavy-duty street circuits where the improved thermal performance of the latest package became a necessity. For 2025, however, the 24 Package has been mandated across all road and street circuits to avoid penalising new teams that don't have access to old stock. This is the only fundamental change to the brake package this year, but the teams are still looking closely at the set-up that they run.

> *"The 24 Package marks the latest step in a process of evolution that began in 2017"*

"As with anything new, there's a slight learning curve around how to manage it for air flow and temperatures ▶

How IndyCar tech is trickling down

THE carbon-carbon brake package used in IndyCar is unique to the series, but as the pinnacle of PFC's motorsport offerings, it feeds into the company's other projects.

"Being the spec IndyCar supply gives us a lot of opportunities to work with the teams. We do a lot of dyno testing and a lot of simulation," comments PFC's technical programme manager James Borner. "That does trickle into our other series when we're looking at high temperatures or materials. The pad compositions aren't the same, but the way that you deal with brake energy remains the same, whether it's an iron system or a carbon-carbon system."

IndyCar generates a huge volume of data that PFC can use to fine-tune its simulations, he explains: "We can apply that in other series where we might not have as much data coming back and still be very confident in the results. The design work we do for things like caliper stiffness at elevated temperatures translates very well. Many of our components are fairly similar in terms of caliper technology and things like piston caps." RT

Photos: Joe Skibinski

ABOVE PFC's IndyCar innovations trickle down into the 15 international championships it supplies

ABOVE Pato O'Ward at pace – and off the brakes – during April's Indianapolis test

Giorgio Piola

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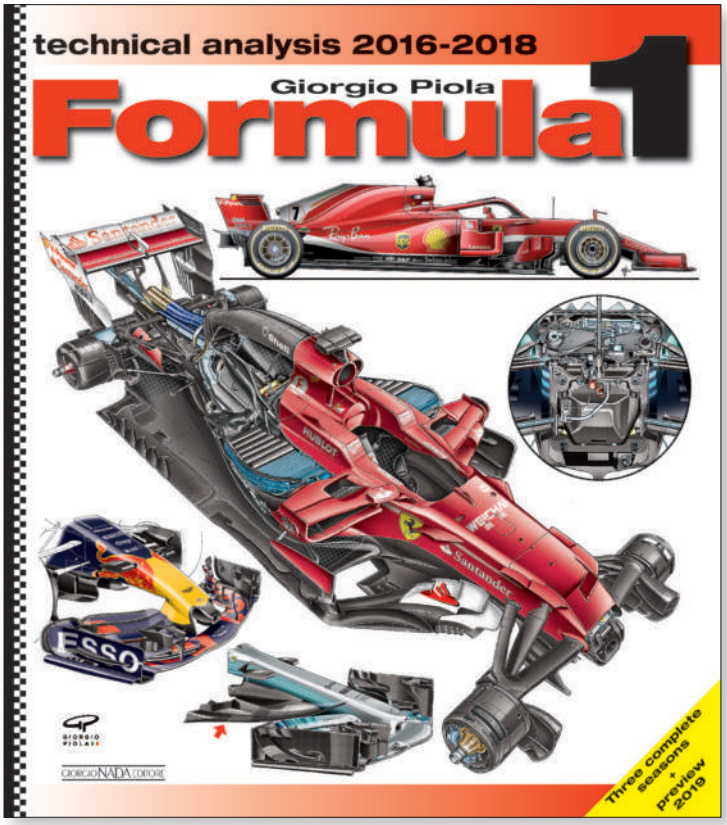

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properly," notes Borner. "Partly, it was just easier for the teams to stick with known hardware last year. Sometimes a minimal change on the rear axle to a new system can bring unexpected changes with the variations we see during a race weekend. Given that the older package didn't cool as efficiently it was easier to keep the minimum temperatures up."

Broad challenge

Unlike the super speedway at Indianapolis, the drivers do use the brakes to scrub speed into the corners on some of the shorter ovals. However, the brake usage is still very mild compared to the road and street courses, partly because the cars run so much downforce on short ovals that it significantly increases the aerodynamic drag in comparison to the super speedway.

"On a lot of short ovals, the teams don't run the glove ducting or the ram air scoops that really drive a lot of air into the brake system, because they don't need the same cooling potential. Generally, they use the pad retraction system on all the ovals, because the brake loads are not a concern for temperature. It's far more critical to tune the brake temperatures on a road course or a street course. With qualifying times sometimes separated by a thousandth of a second in IndyCar, it can make a real difference if you're able to go two feet further into the braking zone," says Borner.

Regenerative braking for the hybrid system has the most noticeable impact on road and street courses, but it can also come onto play on short ovals, he notes. The teams are able to adjust whether they rely solely on the mechanical brakes or set the car up to scrub some speed with regenerative braking; in the case of the latter, the driver might shift the mechanical bias forward slightly to compensate. ▶

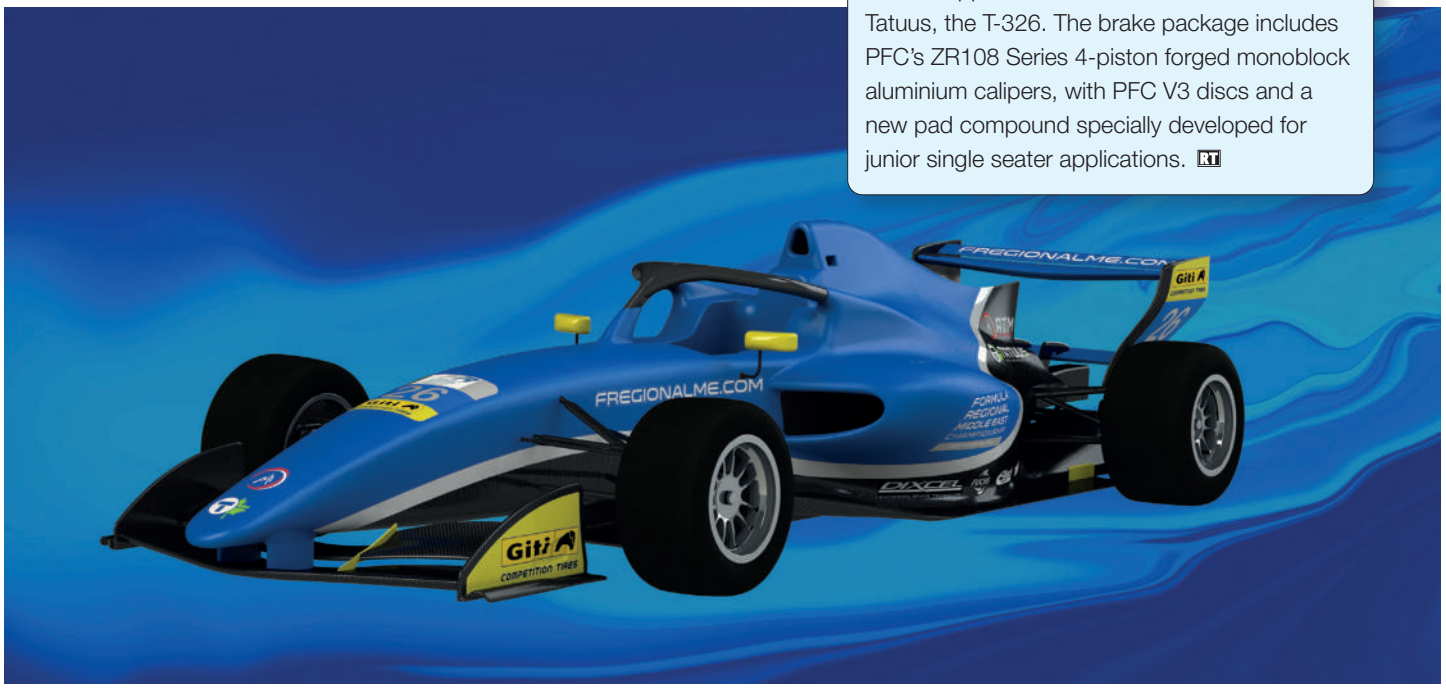
ABOVE PFC's IndyCar brakes are put through their paces on the dyno

BELOW First view of the FR Middle East Tatuus T-326 launched by the Championship in February (pending FIA approval)

The single seater ladder

PFC supplies the complete Indy series portfolio, which includes working with chassis supplier Dallara on the Indy NXT series (formerly Indy Lights), and with Tatuus on the lower rungs of the USF ladder: USF Pro 2000, USF2000 and USF Juniors. The company also supports numerous other junior single seater categories, including Formula 4 in the US, UK, Spain and Brazil, along with Eurocup-3, GB3 and Formula Regional US (Ligier).

Formula Regional (based on Formula Three) is another major area, with PFC recently appointed as the supplier for the new Gen 2 car from Tatuus, the T-326. The brake package includes PFC's ZR108 Series 4-piston forged monoblock aluminium calipers, with PFC V3 discs and a new pad compound specially developed for junior single seater applications. RT



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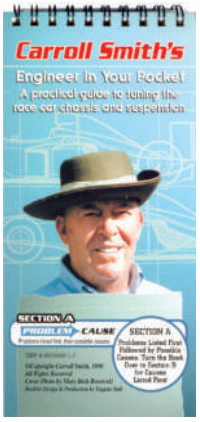

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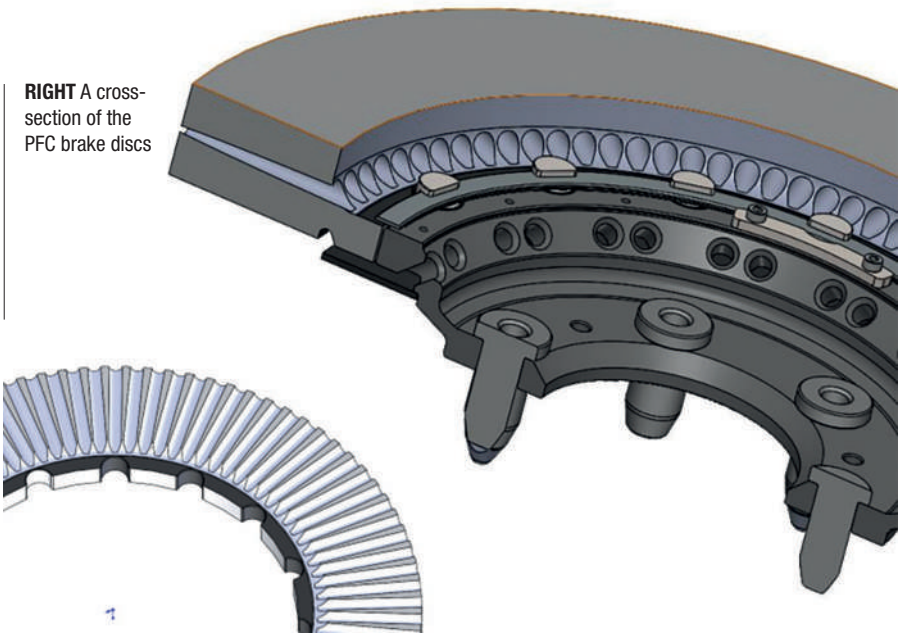
Designing a single brake package that would cope with all four types of circuit on the IndyCar calendar was a formidable technical challenge. Much of the issue comes down to designing high-performing hardware that also provides a broad range of adaptability.

"Some of the road courses require the heavy-duty front package, but some like Barber use a much lighter duty brake package," explains Borner. "Sometimes, the teams will start with a brand new stack on the front, then once it's partially worn, it will be skim cut and transferred to the rear for a street course. By skim cutting the carbon they can get a very customisable stack up."

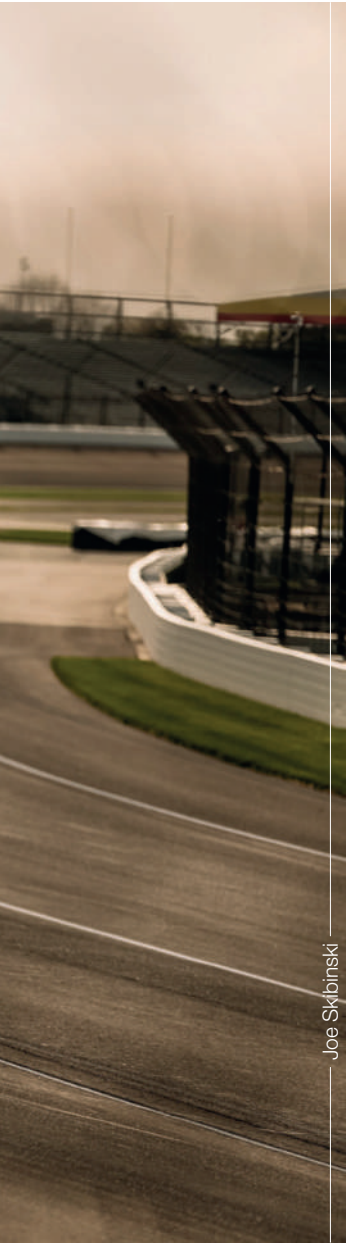
There are also variations in the piston assemblies. PFC's IndyCar brakes use aluminium pistons, topped with either stainless steel or titanium caps. The stainless steel cap is a thin item that allows a thick stack of carbon to be used for maximum thermal mass; the titanium cap is significantly taller, which



RIGHT A cross-section of the PFC brake discs

RIGHT The PFC braking system has been adapted for the arrival of hybrids in Indycar

BELOW Helio Castroneves leads a line of cars at April's Indianapolis test


Joe Skibinski

> *"Designing a single brake package to cope with all four types of IndyCar circuit was a formidable technical challenge"*

pushes the piston back into the bore for better hydraulic stability as well as to suit thinner stacks for less brake-intensive tracks. There is also a choice of two different coatings for the pistons.

"We start off with a thickness of 30mm for the rotor and 24mm for the pads and the teams are allowed to run down to 21mm and 11mm respectively on an oval. So, that's a pretty big variation in stack thickness, especially for carbon," comments Borner. "That allows the teams to choose the thickness to give them different thermal behaviour and friction characteristics to suit the race conditions and the driver's preferences."

A full-size stack is 78mm (a 30mm disc with a 24mm pad on each side) and the thinnest combination goes down to 43mm (a 21mm disc with 11mm pads) meaning that the package has to accommodate 35mm of wear change. Initially, the system will self-adjust, but beyond a certain point, the teams have to change to the taller titanium caps.

Future plans

The Dallara DW12 has served IndyCar well for the past 13 years (in various forms) but an all-new car is planned for 2027 or 2028, tipped to be lighter and equipped with a more powerful hybrid system. PFC is already looking at what implications this might have, Borner explains.

"A greater use of the hybrid system would potentially change what we need to do – particularly on the rear axle (as you're unlikely to have any energy recovery on the front axle on an IndyCar). We'd have to look at the mechanical design to ensure that the system didn't end up running too cold if more of the braking was done by regen," he comments.

"Each track would have different scenarios for what its rear axle brake cooling needs would be. We want to be mindful of how our designs might need to change to work with a broader range of hybrid strategies, but at the same time we're conscious that it's a spec series and we don't want the teams to have to invest in 20 different variations. So we're looking at things to investigate from our side, and then we'll see where the series goes as well with any further move into the hybrid world."

There are no such complications for the teams to worry about this year, but the first Indy 500 of the hybrid era will surely serve up plenty of drama. RT

LABOUR OF LOVE

Hal Ridge tracks down the Roger Clark Motorsport Gobstopper III – a high performance car loosely based on the Subaru BRZ now used for Pro Class Time Attack racing

"**HALFWAY** through I kind of thought: 'Oh my God, what have I started here?'" That utterance by engineer Matt Clark is one with which many who have embarked on a competition car project can undoubtably empathise. But only a relative handful will be able to recognise the enormity of the project that Clark embarked on as the next step in a self-created lineage.

After all, while the machines known as Gobstopper I and Gobstopper II were based on steel-bodied Subaru Imprezas, this latest creation from Roger Clark Motorsport's Leicestershire workshops – while aesthetically a Subaru BRZ – is in reality a fresh-air, clean sheet of paper build. In fact, the only original BRZ parts that have actually been used are the door handles and hinges.

Gobstopper III is the natural successor to its predecessors which played a part in changing the shape of RCM's business model. They also helped create a performance Subaru industry leader, especially with their flat-four boxer engine delivering the kind of results not reliably seen on Planet Earth, arguably ever.

Prior to the creation of Gobstopper I, RCM was involved in rallying where Subarus were commonplace – in part thanks to Subaru and Prodrive's efforts at the highest echelons of the sport with legends Colin McRae, Richard Burns and Petter Solberg and the standard four-wheel-drive system for ease of use.

But, in a period when the Impreza was becoming increasingly popular as a fast road option, enquiries at RCM for performance upgrades were on the rise, and it was that interest that sparked a change in direction.

"We started going more towards looking after performance road cars, bringing them from Japan and doing engine rebuilds. The tuning scene with these cars was getting more and more popular and people started using them for all different sorts of motor sport including circuit racing and drag racing, not just rally," explains Clark. "We were going more towards the road tuning and track day market, then Time Attack was introduced to the country..."

Tuning in

A discipline that had been running in Japan and Asia for some time, Time Attack's arrival in the UK gave an opportunity for tuning and performance companies to enter competition and display their wares without the requirement to go into circuit racing. Built specifically for the new discipline, in 2007 RCM's first Gobstopper, now known as Gobstopper I, was born. After finishing second in the maiden campaign of Time Attack with Olly Clark at the wheel, in 2008 and 2009 RCM won the series, and also took part in events like 'ten of the best' targeted directly at tuning outfits.

"It just got more and more popular from there. We started doing more on the Subaru parts and tuning parts side, which is probably 90 percent of the business now. So in 2013, we built Gobstopper II," says Clark.

While Gobstopper I had been a glorified

> *"I really wanted to build our own car from scratch – not using a body shell"*

road car with no real aerodynamics and bolt-on upgrades, the second iteration was fundamentally based on a WRC platform for the chassis, but also featured ABS braking, paddle shift transmission and a moved engine position. In its first year (2014) the car won the UK Time Attack series, then claimed famous victories in the Goodwood Festival of Speed Shootout during the following two years. But for Matt Clark and RCM, there was still something missing from the CV.

"I decided I really wanted to build our own car from scratch – not using a body shell to start with. It still had to resemble a Subaru of some description for business reasons, so we had to choose a car that best suited what we'd be doing for the future. The BRZ was the perfect car for that. It's quite small, quite low and quite aerodynamic as a shape."

With the base shape chosen, work began on planning the packaging of a four-wheel-drive powertrain, while adapting the BRZ concept to maximise the potential of the external surfaces, clad around the tubular steel spaceframe chassis.

"The car is to scale [with the OEM BRZ] but the shapes are slightly changed. The roof is a bit lower and the screens are lower and shorter. Gobstopper I is 1130kg, Gobstopper II 1190kg – because the hatchback is a slightly bigger, heavier body – but Gobstopper III is just 950kg, which is obviously a really nice weight saving." ▶

BELOW Building the Gobstopper III has been a huge challenge for Roger Clark Motorsport

All Images: Roger Clark Motorsport

Clearly a huge step forward on the aerodynamics side from its predecessors, the aero on Gobstopper III was designed by Andrew Brilliant, while the car underwent wind tunnel testing at the Mira facility.

"A lot went into that," adds Clark. "Andrew lives in Japan but does a lot in the World Time Attack series over in Australia. He came over, we discussed the project and he did the key shapes and aero requirements for the car, then all the CFD [Computational Fluid Dynamics] before we started producing the moulds and everything. That was the biggest challenge, packing everything in [within the self-enforced external parameters]. Obviously when you start with a body shell, you've got limitations you can't really do a lot about. But when you start with a blank sheet of paper it's definitely a bit of a head scratcher. With this being four-wheel drive, having a turbo, intercoolers, intercooler pipes, packaging was quite difficult especially because you had to come up with a design package at the beginning and hope that it still worked by the time you got to the end. There's so much going on with this; squeezing it all into quite a small package in the middle of the car."

> *"When you start with a blank sheet of paper it's a head scratcher"*

The car's aero produces two tonnes of downforce at 150mph, thanks to the triple vein rear wing and front splitter, in addition to the changes to the RCZ's shape. Also at play is the huge rear diffuser, but the exhaust doesn't exit the car to create a 'blown diffuser' effect, largely due to the packing constraints, especially with the rear driveshafts. Yet the biggest party trick for

ABOVE The Gobstopper III undergoes testing in the wind tunnel

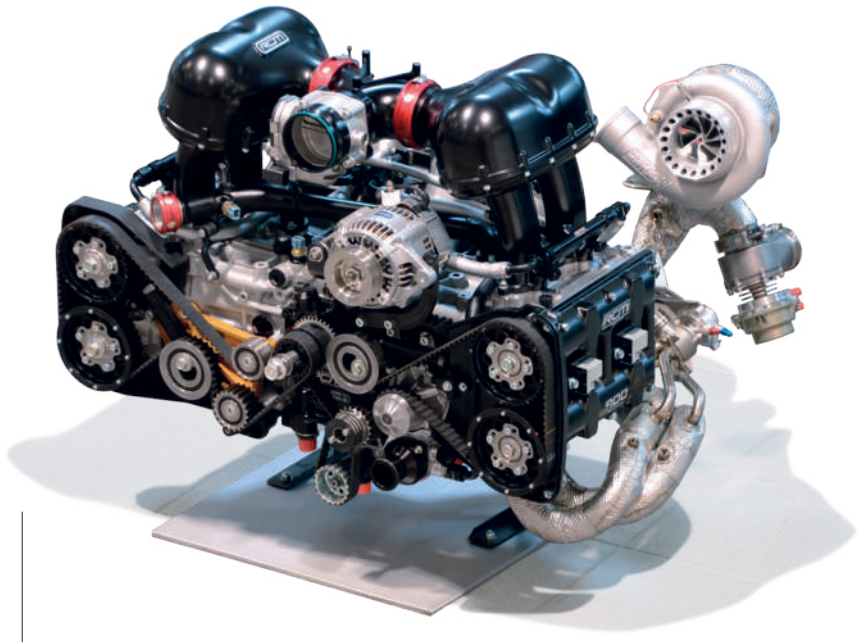
RIGHT Underneath the Gobstopper's bodywork sits a tubular steel spaceframe chassis

Gobstopper III is the third Nitron damper with Eibach spring used front and rear, a bell crank system in addition to the more conventional double-wishbone suspension front and rear, that takes care of the high and low speed aero control.

No turning back

Underneath the bodywork, including a half-door for weight saving, the engine sits under the windscreen rather than in the engine compartment, to the extent that to work on the car between events, the windscreen is removed for access.

Clark recalls: "I don't think I appreciated how much more of a project it was at the beginning [than the previous Gobstoppers]. But certainly halfway through I thought: "Oh my God, what have I started here?' We made our own transmission for this one [together with DJM]. The problem with the Subaru transmission is that it limits how far back you can push the engine, because the driveshafts come out ▶



ABOVE RCM's EJ20 flat-four closed deck boxer engine delivers 950bhp, having been developed across all three Gobstoppers

Matt Woods

the front. You get to a point where your driveshaft angles get obscene, so on Gobstopper III we put a differential in the front and the engine behind the diff. Then the [carbon] propshaft runs down the centre of the car. The engine is offset 150mm in the chassis, which is basically the distance from the crank centre line to the output of the propshaft front and rear. The engine sitting offset works quite well to help balance out the driver weight because it doesn't have a co-driver or anything."

The 2.0-litre engine's dry sump system also resides in what would conventionally be the passenger seat area, sitting behind the Turbo Precision 6670 Next Gen turbo. But, while Gobstopper III is all new in most areas compared to its older brothers, when it comes to the engine itself, the 2.0-litre unit is one that has continued to be developed by RCM from the start of the Gobstopper journey.

> *"No one can tell you how to get 950 horsepower out of a two-litre Subaru engine"*

The engine block and cylinder heads of the EJ20 flat-four boxer engine remain the same as they have throughout the Gobstopper story, utilising a closed deck, no head gasket approach, instead adopting gas rings to be able to achieve 2.6 bar of boost, based on a World Rally Car concept. The heads feature beryllium value seats and bronze valve guides, while the valves themselves are one-piece Iconel +1mm oversize, with the cam shafts made from gun drilled billet steel.

The latest iteration, which has a bore of 92mm and a stroke of 75mm plus a compression ratio of 10:1,

ABOVE & BELOW RIGHT The Gobstopper III has the lines of the Subaru BRZ but little else

BELOW The Gobstopper III in its element, blasting around the world's racetracks

runs a twin-belt timing belt set-up. The eight 1500cc injector inlet manifold is all new, with throttles sitting on top of the manifold while also using drive-by-wire and fresh air anti-lag systems, controlled by the Syvecs S12 ECU.

Nitros has been a big part of the Gobstopper performance story but in its current iteration the car is now producing more power without Nitros – at 950BHP and 650lb torque – than it was 'back in the day' with Nitros added. While Gobstopper III is home to a Nitros bottle, development on that side of the project is on the 'to do' list.

On the exhaust side of the engine, the manifold and 3¾" diameter system are bespoke, made from Inconel, while the intercooler, like the water radiator and oil cooler, is made by PWR of Australia with the units sitting up front in the car for best airflow and weight distribution. The fuel tank sits in the rear of the chassis to the left side to further help with the weight distribution.

Between the engine and transmission, a 140mm four-plate Alcon carbon clutch provides the drive to the six-speed sequential gearbox, operated by a paddle shift system with paddles between the steering wheel and the MoTec dash in the cockpit. Within the transmission itself are the front and rear differentials, but the centre unit is active.

"We've got that same two-litre race engine that we've been developing since just before Gobstopper I, which was loosely based on a WRC spec engine at the time," says Clark. "We evolved it to suit our own needs year on year to where it is now. It has good performance in a very small light package. It's a great little engine to put in a race car because with it being a flat engine it obviously doesn't stand up so it's very low and works well in that situation. The centre diff has an electromagnetic solenoid on it that can vary the pressure onto a clutch pack. We can use that to tune whatever we want to do with the handling on track.

"Because we made the transmission from scratch, that was a learning curve. It has an electronic shift system where the shift motor basically goes straight into the end of the barrel and just spins the barrel around. There's no linkage, it's literally just a sequential barrel which pokes its head out at the end of the gearbox casing and a motor that goes on the end of it and flicks it round. That's quite a trick thing which took a lot of setting up and getting right, but now it's fantastic. If you were using any off-the-shelf transmission, you wouldn't really have that."

Each driven wheel is a forged billet 18x12 ET26 rim produced by Team Dynamics [clad with Pirelli tyres] with a centrelock nut. Within the rims, Alcon carbon ceramic discs, 380mm on the front and 340mm on the rear, are joined by monoblock brake calipers, operated via an Alcon pedal box in the cockpit and a Bosch Motorsport ABS system.

Pride and joy

The most extreme creation to have been delivered by RCM in its 32-year history, chief engineer Clark is clearly proud of Gobstopper III, but like all such projects, they are labour of love. Asked if the machine was only possible because of it was for themselves first and foremost, Clark laughs.

"Obviously doing a second car would be a billion times easier than doing the first one. We've got a lot of the tooling in the moulds and everything for the car now so it would be possible to do a second one, but it would be reasonably expensive," he muses.

"This was something I wanted to do for my own learning curve as much as anything. With all three of the cars, they have been fantastic learning curves which you would never get unless you bit the bullet and tried to do it yourself. There isn't anyone who can tell you how to get 950 horsepower out of a two-litre Subaru engine, so you just have to go through the pain and beat things up along the way. Eventually you get to a point where it's a really reliable lump like we've got now. We go all season without touching the engine, which is something I was really keen to try and do. You don't learn stuff like that unless you go through a bit of pain. After building Gobstopper III there is nothing really that we couldn't build now. I've learned so much from it that you can't really put a price on that either."

Clearly Gobstopper III is in the refining stage while RCM seeks to increase its performance threshold, but surely the moral of this story is that active minds need feeding... so will just tweaking an existing machine be enough to satisfy a mind like Clark's? Only time will tell. RT

STEER CLEAR

Chris Pickering investigates Cosworth's next-generation CCW Mk3 steering wheel, tailor-made for the arrival of hybrids in the IndyCar Series

BELOW Cosworth's latest CCW Mk3 steering wheel in all its glory

WHEN we talk about the connection between car and driver, there's one point of contact that springs immediately to mind.

With its fundamental role in controlling the trajectory of the car, the texture of the road surface bubbling back to your palms, and the ebb and flow of suspension forces over bumps and camber changes, no other point of connection can rival the immediacy of holding a steering wheel.

A modern racing wheel, of course, provides an interface with the car in a whole host of other ways too. From switching ECU maps to monitoring hybrid energy deployment, it remains the single most important input and output on the car.

> *"Drivers have specific ideas about what they want from the grip design"*

The steering wheels in IndyCar have to contend with more functions than most, particularly since the arrival of the hybrid powertrains last year. Facing this increasing complexity, many of the teams have now adopted the new Mk3 version of the Cosworth Carbon Wheel (CCW). Originally launched as a general purpose wheel to be used in a variety of motorsport categories, Cosworth has developed a special version of the Mk3 for IndyCar, tailored specifically to the needs of the series.

All teams in IndyCar are required to use Cosworth's dashboard display, which mounts onto the wheel, along with a small electronics module. Some teams integrate this into their own custom wheel, but many had previously chosen to use the Mk3's predecessor, the CCW Mk2, as an off-the-shelf alternative.

"Shortly after we launched the original CCW Mk3, two IndyCar teams came to us within a couple of weeks to ask: 'We've seen the new wheel in IMSA, do you have one that we could evaluate?'" recalls Cosworth's US motorsport manager Ethan Duncan.

He took a sample to the first race that year at St Petersburg, where the teams were generally impressed – but they came back with a couple of requests.

"The main takeaway was that the drivers liked it, and teams like all the

functionality behind it, but it needed some changes for the series," he explains. "There's no power steering in IndyCar, and if you're on an oval you're holding the steering at an angle the whole way down the straights, so the drivers tend to have some quite specific ideas about what they want from the grip design. The other thing is, because they have to put quite a lot of torque through the wheel, they felt that the standard Mk3 was a little small in diameter. If they don't have enough leverage, it impairs their physical ability to turn the wheel."

Grip designs were already a hot topic in IndyCar, with a number of drivers using grips that were custom-moulded to their hands by that point. A general trend was emerging of adding more material at the top of the grip to provide support, so the drivers could relax their hands slightly on the ovals.

One of the decisions taken early in the development of the IndyCar-spec Mk3 was to supply the wheel without grips. In preparation for this, Cosworth consulted one of the leading grip manufacturers that works with the IndyCar teams to understand the moulding process and ensure that the heat involved wouldn't damage the electronics inside the wheel.

Cosworth also consulted IndyCar's medical team on the shape of the wheel, ▶

as Duncan recalls: "There was a driver who broke his thumb in a crash at Toronto last year. There's no power steering pump to take the force in an impact, so when he hit the wall the wheel he was using snapped round and caught his thumb. The advice from the medical team was to open up as much space as we could around the driver's thumbs. With the new design, even if people are using really large grips, there's still a lot more space than there was on the old wheel or the custom designs that people were running."

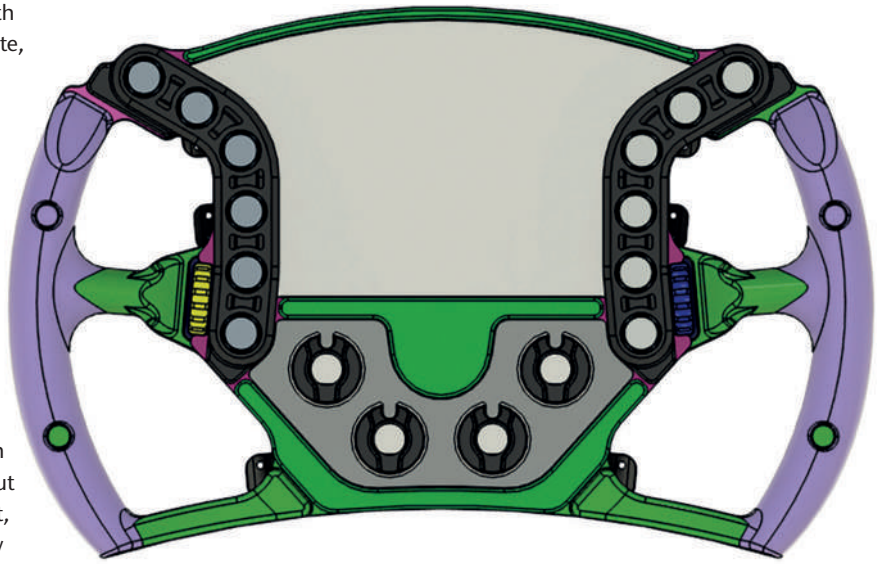
Structural safety is also a priority. The CCW Mk3 has been tested and approved by the FIA using a series of crash tests. These include a drop test, where a weight is dropped onto the wheel to check for deformation or failure; a torsion test, where the column is clamped solid, while a specified torque is applied to the grips; and a lateral loading test that follows a similar process.

> *"IndyCar has seen a trend towards more complex steering wheel functionality"*

The centre of the IndyCar wheel is essentially the same as the regular CCW Mk3. However, the carbon fibre spokes that extend outwards have been enlarged to a nominal diameter of 295mm, though the width can be tailored from 284mm to 315mm to balance turn-in response against steering weight.

Duncan recalls: "After Indy [2023] we did a bit more R&D and some work around the business case. Early last year we 3D-printed a prototype of a larger wheel and took that to the teams. A couple of the engineers came out from the UK and we literally walked around the garages asking: 'What do you think?'"

The expectation, he explains, was that Cosworth might sell 12 or 15 IndyCar-spec Mk3s but, to date, 50 wheels have already been supplied.



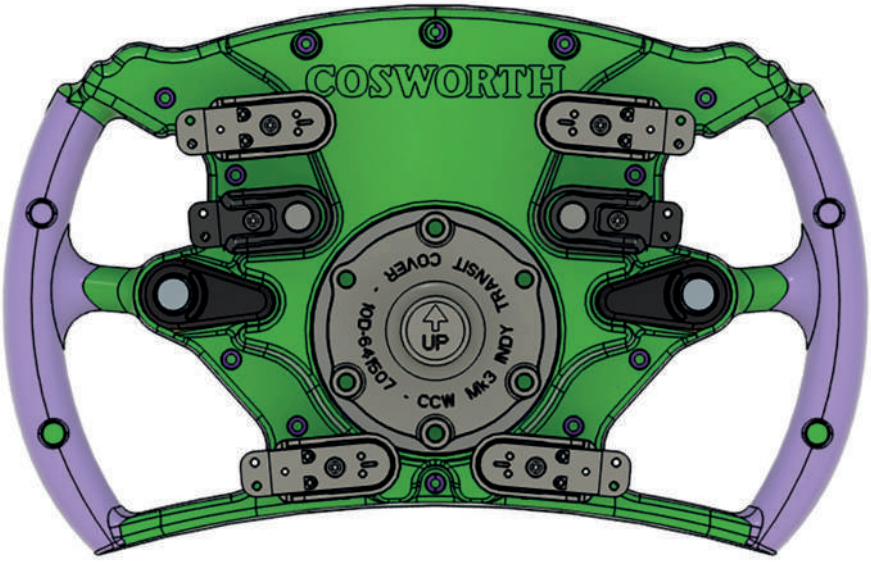
Reinventing the wheel

IndyCar has seen a trend towards more complex steering wheel functionality lately. One of the motivating factors in the adoption of the CCW Mk3, Duncan believes, is the increasing number of functions that the teams wish to accommodate.

"Previously, teams were starting to find they had maxed out the electronics module that they have to use," he explains. "They couldn't add any more buttons or rotary switches to their own custom wheels. A couple of the teams worked out that if you wanted to add more functionality to it, you had to buy a second circuit board, somehow

Chris Owen

LEFT IndyCar racer Alex Palou (pictured at Long Beach) has praised the Cosworth Mk3 for its flexibility



BELOW & BELOW LEFT The CAD imagery of the front and rear of the CCW Mk3

fit it inside your current steering wheel and then still have space on the steering wheel itself to add another control. That's potentially quite a big re-engineering exercise just to add one switch, which is perhaps why a majority of the teams have now gone over to the Mk3 instead."

Compared to the CCW Mk2, the new wheel has two additional buttons. Both have 12 detent positions but the Mk3 uses encoders. On the back, it has dedicated inputs for up to two push-pull digital paddles and four analogue paddles. On the front, the display size has increased from 4.3 to 5 inches, with improvements to the brightness and contrast.

All the controls and display functions are fully configurable. The wheel also has a significant amount of processing capability and 4GB of onboard storage, which means it can run maths channels and logic functions on its own. Theoretically, the wheel is smart enough to run the hybrid control strategy on its own, although this is currently outlawed by IndyCar.

"It's interesting to see the differences between the sports car drivers and the IndyCar drivers," says Duncan. "Originally, the rear buttons were at the top and the feedback we had from the sports car drivers was that they were hitting them accidentally, so we moved them up and out of the way. The IndyCar drivers are completely the opposite. They don't want to move their hands that much. So, because they can customise all the buttons and map them differently, most drivers want push-to-pass and hybrid deployment on the back of the wheel. Those buttons have been moved down almost onto the back of the spoke, so they don't have to reach up to use them while they're racing at 230mph."

While careful consideration has gone into providing support for the driver's hands while dealing with staggered set-ups on oval tracks, the wheels themselves are symmetrical. The same wheel is used without any modifications on both road and oval courses.

The Cosworth engineers are proud of the light weight they've managed to achieve, despite the additional functionality that the CCW Mk3 brings over the Mk2 and the increased diameter of the IndyCar variant.

"I remember speaking to the teams ▶

seven or eight years ago, when they were managing to get a significant weight saving by engineering their own custom wheels instead of using the Mk2," adds Duncan. "The feedback from the teams when we were developing the Mk3 was that if it was more than a pound [454g] heavier it would be worth them designing and maintaining their own wheels instead. But with all of the changes, the gap between the standard Mk3 and the lightest custom wheel that we're aware of is down to a quarter of a pound [113g]. At that point, it's easier to shave that weight somewhere else than to try to take it out of the steering wheel."

> *"The CCW Mk3 is one of the most sophisticated steering wheels in the world"*

The configurability has allowed teams switching over from the Mk2 or from custom wheels to maintain a similar control layout. After all, it helps to have an instinctive layout when you're adjusting settings while wheel-to-wheel with 30 other cars at nearly four miles per minute. To aid this, the Mk3 uses brightly backlit colour-coded buttons.

"If you're on an oval and the caution comes out, the first thing everyone does is adjust their fuel map. If you've got a new driver for the weekend they might not immediately know where that is, but you can write a control strategy into the wheel that will flash that rotary selector as soon as the signal comes through to the dashboard to say there's a caution," explains Duncan.

IndyCar has retained its boost pressure-based push-to-pass system as a separate function in the hybrid era. Whereas drivers are given a maximum duration of push-to-

pass overboost that they can use during the race (typically 150 to 200 seconds depending on the track), the hybrid assistance is available any time they've harvested sufficient energy to use it.

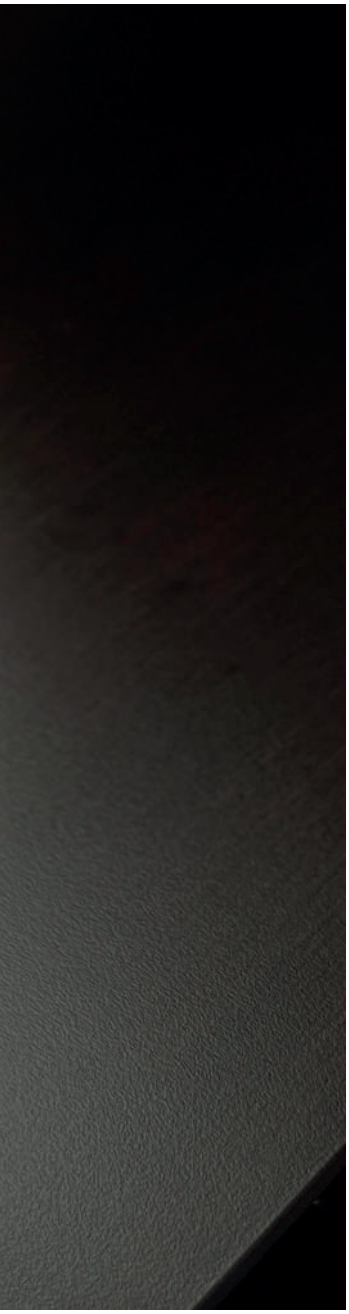
In terms of the steering wheel controls, this requires the addition of one extra button to deploy the hybrid system and another if the team wants to manually activate regen. Not all drivers used the full range of functions on the old steering wheel, but for those who did, the only way to retain that functionality alongside the new hybrid controls has been to modify or replace their steering wheel.

With its roots in hybrid sports cars and the highly-specialised world of IndyCar, the CCW Mk3 is said to be one of the most sophisticated steering wheels in the world. Indeed its capabilities exceed most of the wheels used in Formula 1, notes Duncan: "You see some nice designs in Formula 1, but their electronics are all under single spec supply, so it's actually quite restrictive in terms of development. And when you're in a budget-capped series like Formula 1 you have to think very carefully about whether you want to spend money developing a brand new steering wheel – the teams have mostly just been tweaking their existing designs.

"Our off-the-shelf wheels have to cater for everything from IndyCar – where the functionality is quite restrictive but the physical demands are quite specific – through to the extreme complexity that we see in some of the LMH and LMDh cars."

Of course, in the grand scheme of things, there are more complex parts on the car. And there are parts that will make a greater difference to the performance. But, just for a second, imagine you're going into the Indianapolis banking at 230mph and you feel an unexpected shimmy through the steering wheel... or perhaps a tyre pressure warning suddenly flashes up on the wheel-mounted display. It's those moments that illustrate just how important the wheel is in connecting driver and machine.

Joe Skibinski



RIGHT The Cosworth Mk3 is already used by eight of IndyCar's 11 full-time teams

RIGHT Cosworth's steering wheels on the Yard of Bricks at IndyCar's spiritual home Indianapolis

LEFT The rear has dedicated inputs for two push-pull digital paddles and four analogue paddles

DEALING WITH DOOMSDAY

Sergio Rinland says that for years Formula 1 has pandered to the manufacturers, but could that policy backfire as economic crisis looms?

LAST month we discussed the not-so-crazy idea of returning to simple, non-hybrid, naturally aspirated engines. V10s were top of the wish-list, because some people remember with nostalgia the noise of those high-revving engines in the early 2000s.

But since Donald Trump got back into the White House, the world of finances has changed on a daily basis. The trade war, initiated in Washington due to the imposition of import tariffs, was the latest bombshell. Hence, the notion of naturally aspirated engines returning to simpler, lighter and more economical Formula 1 cars has taken on a new dimension.

In the wake of the crisis meeting that discussed the sport's next generation engine, F1 CEO Stefano Domenicali addressed the spectre of potential financial meltdown. "If a crisis forces some to pause their F1 programmes, we'll be in a position to respond independently and find alternatives," he suggested.

The Zillion Dollar Question is: what could those alternatives be? The first answer for F1 is that it is "damned if you do, damned if you don't".

If they *do* act and choose to discard the 2026 rules after only a couple of years, now that all those OEMs are investing/spending fortunes in developing the new 50/50 split hybrid V6 power units, they will be shooting themselves in the foot. If they *don't* act, they will be burying their heads in the sand in spite of the fact that all hell could be about to break loose. I would not like to be in their position right now.

After many years of crawling behind the OEMs and tailoring the regulations to what they wanted at that point in time, we find ourselves now in a similar situation as we did in the last financial crisis of 2008/2010: over-reliance on the OEMs, for which F1 is a good marketing tool as long as it is affordable. The moment it is not, they decide to pull the plug as if it were pulling out of an expensive TV advertising campaign.

Only a few weeks ago we were saying how fantastic the future of F1 looks now that so many OEMs have decided to stay and/or to come to F1: Ferrari, Mercedes, Honda, Audi, Ford and Cadillac. Renault did not need Trump's tariffs to pull out; they have their own problems already.

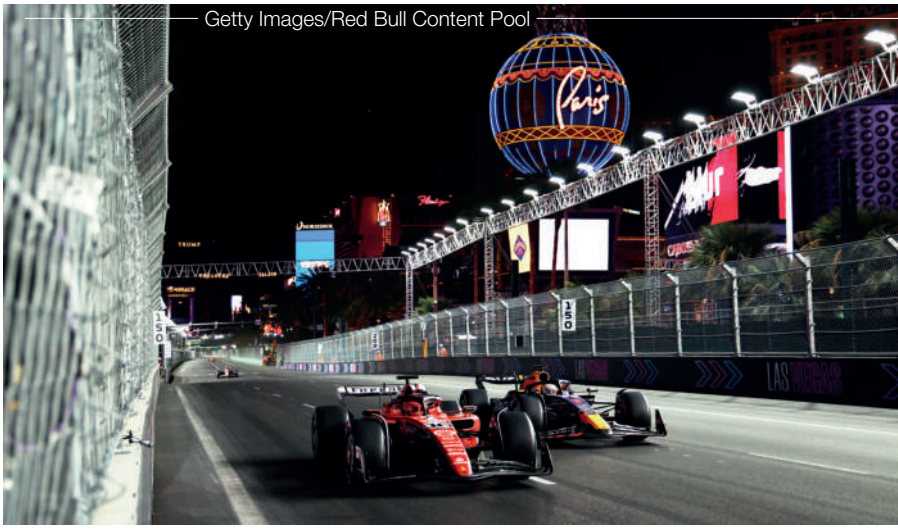
Of all the engine suppliers for the new 2026 regulations, perhaps only Ford, Cadillac and Honda (because they manufacture in the US) may not be that badly affected by Trump's tariffs. All the others will be impacted to some degree or another.

Up until now, the US was a significant market for Ferrari, Mercedes and Audi, with a substantial portion of their exports directed there. That was one of the main drivers for being involved in the now US-centred Formula 1. Will the US market shrinkage prompt them to re-think their marketing strategy? That is anybody's guess.

So, to address Domenicali's comment of "respond independently and find alternatives", unless FOM and Liberty Media decide to set up their own engine manufacturing facility (as Red Bull has done) or turn to someone like Cosworth – as they did in 2010 when the UK-based firm supplied Williams, Lotus, HRT, and Virgin – I cannot see how F1 can "respond independently".

Is that what Domenicali was hinting? If so, that would take time and will certainly upset the current PU suppliers, unless one of them decides to bite the bullet and offer to be the sole supplier. Either way, in my opinion a normally aspirated, non-hybrid, e-fuelled PU with a more efficient cycle than the Otto looks to be the best technological alternative, be that V10, V8 or even V12, but that at the moment has been ruled out, so perhaps a simplified hybrid V6 not as extreme as the current 2026 rules? Any ideas to reduce costs will be welcome.

There is no clear answer as yet as this messy saga rumbles on. What we need are time and clarity of mind: but time is scarce and I am not sure about the latter.



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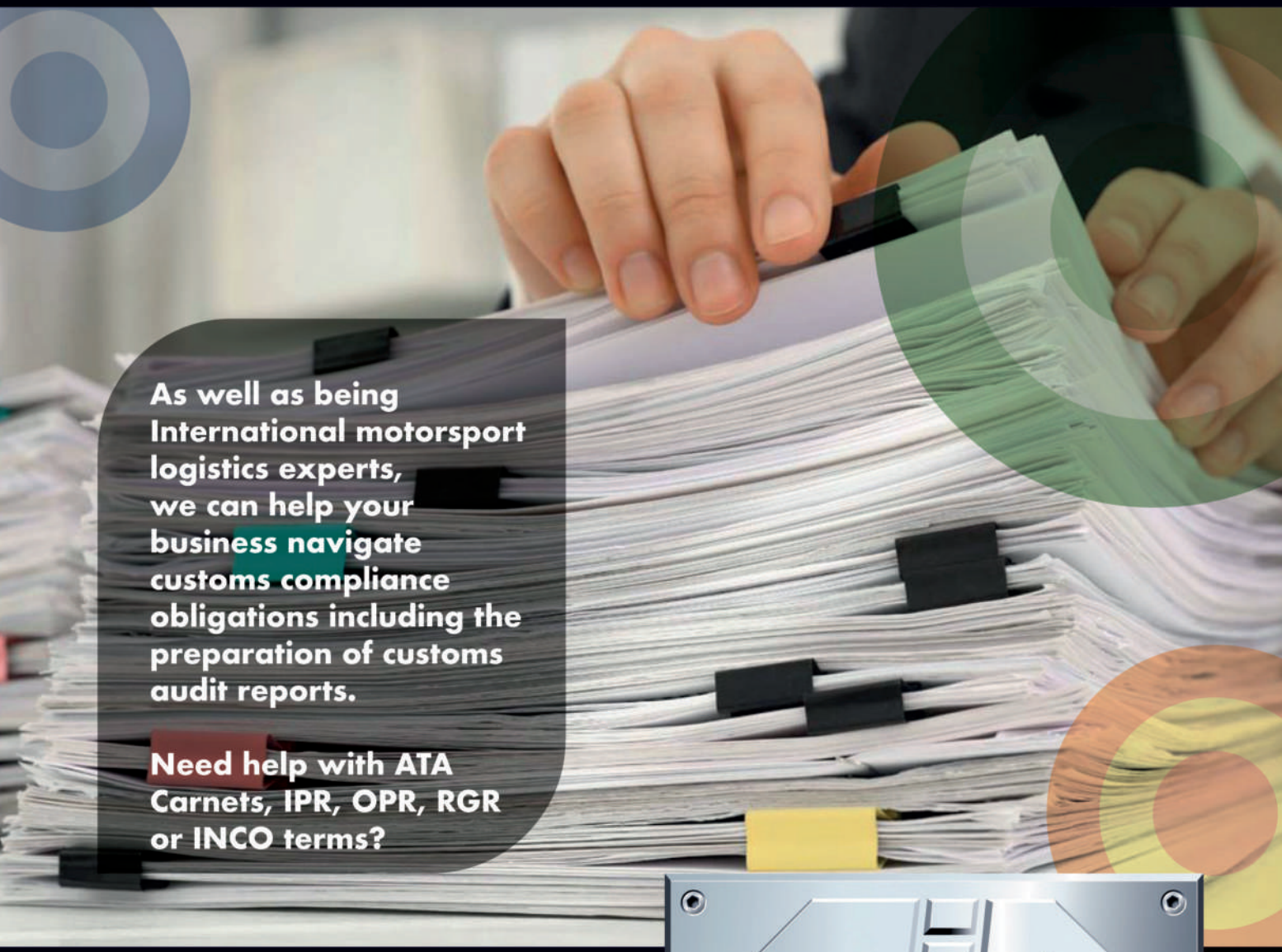

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